E-MINDFUL HEALTH: EVALUATION OF MOBILE APPS FOR MINDFULNESS

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Abstract

Young people report higher levels of psychological distress and are more vulnerable to mental health disorders than other age groups, yet are the least likely to seek help. The traditional illness-focused health care systems are unable to meet the complex mental health needs of this vulnerable group. There is an urgent need to engage young people with high prevalence mental health problems into effective treatment.

Mindfulness has been gaining empirical support in the last two decades as an effective treatment for variety of mental health conditions including stress, anxiety and depression. Mindfulness has roots in Buddhist philosophy which aims to alleviate people's suffering. While Buddhism and related practices were introduced to the western world mostly by Buddhist monks (like Nyanaponika Thera and Thich Nhat Hanh), mindfulness attracted scientific attention through Jon Kabat-Zinn's mindfulness-based stress reduction (MBSR) program, which has demonstrated effectiveness in both clinical and non-clinical populations. Other mindfulness-based (mindfulness-based cognitive therapy; MBCT) and mindfulness-related interventions, including dialectical behaviour therapy (DBT) and acceptance and commitment therapy (ACT) are evolving and are gaining empirical support for improving mental illness. However, the majority of trials of mindfulness-based treatment have used face-to-face training and few have examined its efficacy in young people.

E-mental health (eMH) services, especially mobile health (mHealth) technologies present an unprecedented opportunity to provide scalable, efficacious and cost-effective treatment to young people with high prevalence of mental health problems across the globe. The rapid growth in mobile phone software applications (apps) has been catalysed by the increase in global uptake of smartphones and other wireless devices. Mobile apps provide anonymity, flexibility, internet connectivity and convenience to the user. These characteristics make them a viable choice as an intervention medium, especially for young people. Mobile apps can potentially deliver mindfulness training and aid its practice. There are already more than 600 mindfulness apps in the app store. However, there is little evidence on the efficacy of these apps.

The main aim of this research program (which is presented as a thesis by publication), was to evaluate the efficacy of a high-quality mindfulness mobile app. The lack of regulation or guidelines for health-care app development in general and the numerous mindfulness apps

available in the app stores make choosing a high-quality app challenging. This research addressed this challenge in the following three studies.

Study 1 conducted a systematic review of mindfulness-based iPhone mobile apps and evaluated their quality using a recently-developed expert rating scale, the Mobile Application Rating Scale (MARS). A search for "mindfulness" in the Apple App Store through iTunes and Google search interface identified 700 iPhone apps. The review focused on mindfulness apps that provided mindfulness training and education. Those containing only reminders, timers or guided meditation tracks were excluded. Twenty-three apps met the inclusion criteria. An expert rater reviewed the apps and rated app quality on the MARS engagement, functionality, visual aesthetics, information quality and subjective quality subscales. A second rater provided MARS ratings on 30% of the apps for inter-rater reliability purposes. The median MARS score for the rated apps was 3.2 (out of 5.0), which exceeded the minimum for acceptability on the MARS (3.0). The Headspace app scored the highest MARS average (4.0), followed by Smiling Mind (3.7), iMindfulness (3.5) and Mindfulness Daily (3.5). MARS ratings by the two raters had a high level of inter-rater reliability.

Study 2, a pilot randomised controlled trial, compared the efficacy of a low- and high-quality mindfulness training app identified in Study 1. It also explored young people's perceptions of the usability of apps as a platform for delivering mindfulness training and motivating its practice. Twenty-seven young people (16-25 years) were randomly allocated to a low- (Cleveland Stress Free) or high-rating (Smiling Mind) mindfulness training app. Participants were asked to use the respective app for 4 weeks. Measures of mental wellbeing (Mental Health Continuum-Short form; MHC-SF), psychological distress (Kessler-10; K10) and mindfulness (Cognitive and Affective Mindfulness Scale – Revised; CAMSR) were completed at baseline and 4 weeks later at post-intervention. A semi-structured qualitative interview was conducted with eight participants. Only 10 of the 27 participants (37%) who were randomised to a mindfulness app completed the post-intervention survey. A significant improvement in mental wellbeing was found among completers in both groups. However, no between-groups differences in wellbeing outcomes were found by app type, and no changes in psychological distress or mindfulness skills were found. Qualitative responses indicated participants were interested in learning more about mindfulness. An increased awareness of the benefits of mindfulness was identified as a potential motivating factor to enhance its practice.

Study 3 examined the efficacy of Smiling Mind app for improving the wellbeing of young people in a randomised controlled trial. Young people (16-25 years) with at least mild level of distress were recruited for the study (n=185). Participants were required to have access to an iPhone or an Android phone and have no prior mindfulness practice experience. They were randomly allocated to one of three groups: Immediate access, immediate access with Reminders or a 6-week Delayed access group. Participants in the Reminders group received weekly reminder calls for the first 6 weeks. Mental wellbeing (MHC-SF), psychological distress (K10), mindfulness (CAMSR) and happiness (Oxford Happiness Questionnaire – Short Form; OHQ-SF) were measured at baseline, 6, 12 and 18 weeks. The Immediate group showed a significant improvement in wellbeing at 6 weeks, but the Delayed and Reminders groups showed little change from Baseline. However, from 6 to 12 weeks, the Delayed controls showed an equivalent improvement in wellbeing to that of Immediate group in the first 6 weeks. The Reminders group did not differ from the Immediate access group at any timepoint, indicating the reminder calls had no impact on the outcomes of the Smiling Mind app. The whole sample showed a significant improvement in all outcome measures from baseline to 18 weeks.

In summary, this research program evaluated a novel method for delivering mindfulness training to young people. A review of existing mindfulness apps identified several high quality mindfulness apps. A high- and low-quality app were then compared in a pilot RCT with 27 young people, but no differences in the outcomes of the apps were found, possibly due to the low engagement and follow up rates in this study. A second RCT with the high-quality app was then conducted with 185 young people with at least mild levels of distress to determine the efficacy of the app to improve their wellbeing and the addition of reminder calls increased its effects. Promising results were found indicating the Smiling Mind app provides a potentially effective medium for delivering mindfulness training to young people and enhancing their wellbeing.

The structured and progressive approach of this research program could serve as a guideline for future research involving a mobile health care app. Mindfulness mobile apps may potentially be used as an intervention medium for improving health outcomes of young people. The findings from the studies may inform design and development of effective mindfulness apps.

Publications

Paper 1:

Mani, M., Kavanagh, D. J., Hides, L., & Stoyanov, S. R. (2015). Review and evaluation of mindfulness-based iPhone apps. *JMIR mHealth and uHealth*, 3(3), e82.

Paper 2:

Mani, M., Kavanagh, D. J., & Hides, L. (2016). Mobile Apps for Mindfulness – Results of a pilot study. Manuscript submitted for publication.

Paper 3:

Mani, M., Kavanagh, D. J., Hides, L. & Cockshaw, W. D. (2016). Test of a mobile app for young people's mindfulness – A randomised controlled trial. Manuscript submitted for publication.

Notes

All papers are published in or submitted to peer reviewed international journals. The candidate is the first author on all papers. The second and third authors are members of the candidate's supervisory team and assisted in study conceptualisation, analysis of data and preparation of the manuscript. Wendell Cockshaw assisted in statistical analysis of the study presented in Paper 3. Permission has been granted by all co-authors for the inclusion of the papers in this manuscript.

Ancillary Publications

Stoyanov, S. R., Hides, L., Kavanagh, D. J., Tjondronegoro, D., Zelenko, O., & Mani, M[*]. (2015). Mobile App Rating Scale (MARS). A new tool for assessing the quality of health mobile apps. *JMIR mHealth and uHealth*, 3(1), e27.

Stoyanov, S. R., Hides, L., Kavanagh, D. J., Sanders, D., Cockshaw, W. D. & Mani, M. (2016). A recommended process for development and evaluation of eTools for mental health and wellbeing. In R. G. Menzies, M. Kyrios & N. Kazantzis. (Eds.), *Innovations and Future Directions in the Behavioural and Cognitive Therapies* (chapter 45). Australian Academic Press.

Notes

[*] The candidate assisted in rating mobile apps for inter-rater reliability purposes and was involved partly in discussions about the items in the scale.

Conference Presentations

Mani, M., Kavanagh, D. J., & Hides, L. (2016, June). *Exploring the quality and efficacy evaluation of a high-quality mindfulness app.* Paper presented in the eHealth programs for mental-health interventions and wellbeing promotion symposium at the Eighth World Congress of Behavioural and Cognitive Therapies, Melbourne, Australia.

Mani, M., Kavanagh, D. J., Hides, L., & Stoyanov, S. R. (2015, June). *Bridging technology and wellbeing: Can a mobile app aid mindfulness among youth and improve their wellbeing?* Paper presented at the Fourth World Congress on Positive Psychology, Florida, USA.

Mani, M., Kavanagh, D. J., Hides, L., & Stoyanov, S.R. (2014, February). *Bridging technology and wellbeing: Can mobile app aid mindfulness among youth and improve their wellbeing?* Paper and poster presented in the Early Career Researchers symposium at the Fourth Australian Positive Psychology and wellbeing conference, Melbourne, Australia.

Mani, M., Kavanagh, D. J., Hides, L., & Stoyanov, S.R. (2014, February). *Bridging technology and wellbeing: Can mobile app aid mindfulness among youth and improve their wellbeing?* Paper presented at the Connect 2014 conference, Young and Well Cooperative Research Centre, Melbourne, Australia.

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Statement of Original Authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

QUT Verified Signature

Signature:

Date: December 2016

Acknowledgments

"Do what is possible by you now. Don't care about what you did not do yesterday!" That's my supervisors' version of mindfulness training in a minute! I can vividly remember the first time I, a stranger to the Australian education system, met Prof David Kavanagh, seeking guidance to take my psychology interest forward. He spent an hour explaining the choices I had. I'm immensely grateful to him for spending that hour which changed the course of my life and the rest three and a half years for helping me lead that course. Often I enter his office with a guilt-laden heart, low self-esteem and usually an unfinished work. I return to my desk guilt-free, appreciating my work and with clarity on 'what next?' That's his magic. Prof Leanne Hides is the other magician I'm grateful to. Her magic gave me strength when I was weak, cleared some hurdles in my path unasked and helped me move forward. Both my supervisors were "ideal" personified. I'm grateful to my wife Nithyalakshmi, who supported me in all her capacity and managed to get through tough times and to the wonderful friends who assisted me and my family at all times of needs. I'm very thankful to QUT and the Young and Well CRC for providing this PhD opportunity.

Epigraph

GOD Grant me the SERENITY to accept the things I cannot change,

COURAGE to change the things I can and

the WISDOM to know the difference.

Living one day at a time; Enjoying one moment at a time;

Accepting the hardships as the pathway to peace;

Taking this sinful world as it is, not as I would have it;

Trusting that He will make all things right if I surrender to His Will;

That I may be reasonably happy in this life,

and supremely happy with Him forever in the next.

--Reinhold Niebuhr

Chapter 1: Introduction

1.1 BACKGROUND

The high incidence and prevalence of mental illness among young people has become a global crisis (McGorry, Bates, & Birchwood, 2013; V. Patel, Flisher, Hetrick, & McGorry, 2007). One in four young Australians (16 – 25 years) has suffered a mental health problem in the past year (J. Slade, Teesson, & Burgess, 2009). Mental health of this age group is critical as most mental disorders have the onset before 25 years of age (Ronald C Kessler et al., 2005) and mental illness contributes 45% of the burden of disability among young people including adolescents* (Gore et al., 2011). The Australian Life Patterns longitudinal study of young Australians (n=1299) from age 19 through 25 found their mental health worsened over time (Landstedt, Coffey, & Nygren, 2016).

Young people with mental disorders are reluctant to seek professional help (McGorry et al., 2013; Miller et al., 2016; Rickwood, Deane, & Wilson, 2007) and only 23% of young Australian with mental disorders accessed health services in the preceding 12 months (J. Slade et al., 2009). Negative attitudes about help seeking for mental health issues are common in young people (Mackenzie, Erickson, Deane, & Wright, 2014), due to poor mental health literacy, stigma and fears of discrimination (Bradford & Rickwood, 2014; Corrigan, Druss, & Perlick, 2014). There are noticeable barriers in availability, accessibility, acceptability, and equity of health services (Ambresin, Bennett, Patton, Sanci, & Sawyer, 2013; Tylee, Haller, Graham, Churchill, & Sanci). Traditional primary health-care services focus on physical-health and are insensitive to the mental health needs of young people (McGorry, 2007). Among those who use clinical services, young people are more resistant than any other age group to accept treatment leading to high treatment-drop-out rates across services (King, Bickman, Shochet, McDermott, & Bor, 2010).

Good mental health is critical to positive youth development (WHO, 2013b) and also influences social and economic outcomes across the lifespan (Herrman & Jané-Llopis, 2012; Jenkins, Baingana, Ahmad, McDaid, & Atun, 2011). Interventions that promote mental health equip young people with necessary skills to manage adversities well and also improve social

* Adolescence, according to WHO, is defined as the period between 10 and 19 years of age. Though this thesis focuses on young people (16 - 25 years), it refers study findings and reports on adolescents' mental health as the age groups overlap.

functioning, academic and work performance and general health behaviours (Baker-Henningham & López Bóo, 2010; Barry & Jenkins, 2007; Nores & Barnett, 2012; Weare & Nind, 2011).

The challenges associated with improving the mental health of young people are two-fold: first, we must identify effective interventions for alleviating mental health problems and promoting the wellbeing of young people, and second and more importantly we must find efficient and highly accessible methods for delivering these interventions. This PhD focuses on mindfulness interventions which have been gaining empirical support in the last two decades as an effective treatment for a variety of mental conditions and the use of mobile apps as a medium for delivering mindfulness training. .

1.2 MINDFULNESS

Mindfulness has its roots in eastern philosophy, especially Buddhism and its practice aims to alleviate people's suffering (Hanh, 2008). Mindfulness was a translation of the Pali word from the Buddhist scriptures, *sati*, which connotes not just awareness or attention but also memory (Thera 2014, p. xvi; Hwang & Kearney 2015, p. 5). Traditionally it is integrated into the spiritual practices that lead to peaceful daily living. Mindfulness was popularised in the 1950s and 60s by the German scholar monk, Nyanaponika Thera who influenced many modern meditation teachers (Hwang & Kearney, 2015). Jon Kabat-Zinn, influenced by Thera's teaching (Kabat-Zinn, 2011), founded mindfulness-based stress reduction (MBSR) program, that introduced mindfulness to the western scientific world. He defines mindfulness as "the awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experience moment by moment" (Kabat-Zinn, 2006). His primary intention to bring mindfulness into the mainstream society was to relieve suffering and catalyse greater compassion and wisdom in our lives and culture (Kabat-Zinn, 2011). The scientific community has ever since accepted mindfulness and there is an exponential growth in mindfulness research literature recently (Figure 1).

Many mindfulness-based (MBSR, MBCT) and mindfulness-related (ACT, DBT) programmes were developed in the last few decades and are gaining empirical support (Khoury et al., 2013b). Though each program has its own perspective and teaches mindfulness in different ways, they overlap in the basic tenets of mindfulness and have all been associated with beneficial effects (Cramer, Lauche, Haller, Langhorst, & Dobos, 2016; Gu, Strauss, Bond, & Cavanagh, 2015). More recent programs target specific problems like

mindfulness-based relapse prevention (MBRP) for substance abuse, acceptance-based behaviour therapy (ABBT) for anxiety and mindfulness-based eating awareness training (MB-EAT) for binge eating and obesity. While some of these programs address clinical conditions

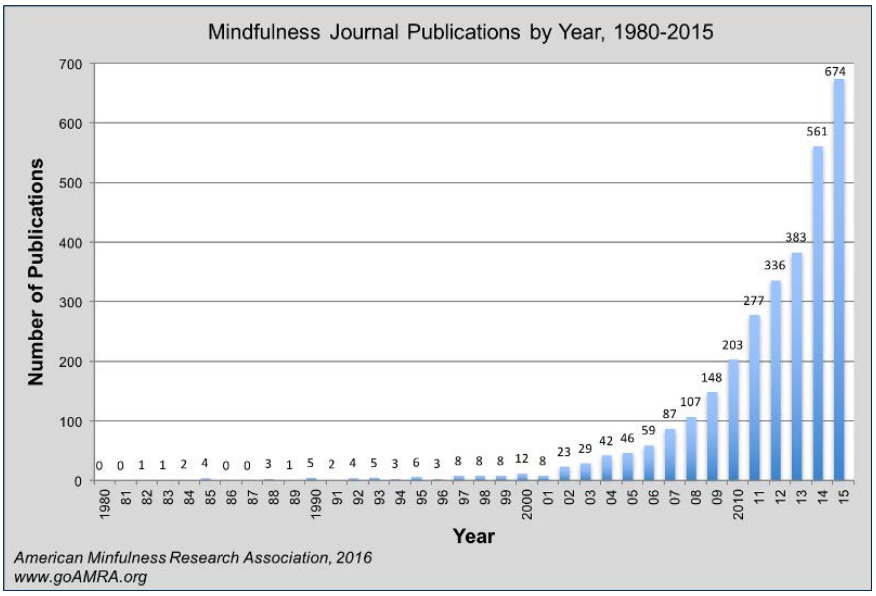

Figure 1 Mindfulness Journal Publications by year, 1980 - 2015

like depression (MBCT), bipolar disorder (DBT), some are more generic and target day-to-day stress (MBSR), psychological flexibility and living a value-based life (ACT).

Mindfulness has been gaining evidence in the last two decades for its beneficiary effects as a health promoting practice and also as a clinical intervention for varied mental conditions (Grossman, Niemann, Schmidt, & Walach, 2004; Keng, Smoski, & Robins, 2011; Khoury et al., 2013b; Neff & Germer, 2013; M. Slade, 2010). Mindfulness-based interventions (MBIs) are found to effectively treat a variety of psychological problems like anxiety, depression and stress (Gu et al., 2015; Khoury et al., 2013b; Khoury, Sharma, Rush, & Fournier, 2015) and also improve quality of life (Coffey, Hartman, & Fredrickson, 2010; Godfrin & van Heeringen, 2010; Josefsson, Lindwall, & Broberg, 2013). Overall, mindfulness practice is found to promote health and reduce symptoms of mental illness. Most studies on mindfulness have tested its effectiveness in adult population. However, there is increasing evidence for the acceptability and feasibility of mindfulness programs in young people as well as their beneficial mental health outcomes (Monshat, Vella-Brodrick, Burns, & Herrman, 2012; Murphy, 2006; Raes, Griffith, Gucht, & Williams, 2013).

1.3 E-MENTAL HEALTH

E-mental health (eMH) is the use of information and communication technologies (ICT) to support and improve mental health, including the use of online resources, social media and smartphone applications (Christensen et al., 2014; Cotton, Hyatt, & Patrick, 2013; Klein et al., 2014). It leverages the advantages of technology to provide cost-effective health care service (Donker et al., 2015). Web-based interventions have demonstrated effectiveness in treating depression (Batterham et al., 2015; Mackinnon, Griffiths, & Christensen, 2008; Richards & Richardson, 2012; Titov et al., 2010) and anxiety (Arnberg, Linton, Hultcrantz, Heintz, & Jonsson, 2014; Spek et al., 2007). Evidence is also emerging for its positive impact on substance abuse including smoking (Civljak, Sheikh, Stead, & Car, 2010; Riper et al., 2014). The rapid growth in mobile technologies and the global increase in uptake of smartphones and other wireless devices provides an unprecedented opportunity to efficiently reach and deliver health interventions to wider audience. Mobile phone software applications (apps) provide anonymity, flexibility, convenience and the benefit of standalone usage with or without Internet. These characteristics make them a viable choice of intervention medium, especially for the technology-savvy young people.

1.4 RESEARCH AIMS

Until recently, mindfulness training was predominantly delivered face-to-face. Mindfulness-training sessions have typically been modelled on MBSR, which has 8 weekly sessions and has suggestions for daily home practice. The cost and availability of the programs may hinder the growth and widespread reach of mindfulness, as face-to-face mindfulness training may not be affordable by all, especially young people. With the advent of internet technologies, online training modes have emerged and are starting to gain evidence for their effectiveness (Cavanagh et al., 2013; Kemper & Yun, 2015; Krusche, Cyhlarova, & Williams, 2013; Laurie & Blandford, 2016; Mak, Chan, Cheung, Lin, & Ngai, 2015; Messer, Horan, Turner, & Weber, 2016; Morledge et al., 2013). Mobile health (mHealth) interventions have extended the advantages of internet technologies further by providing a more scalable, accessible, cost-effective and flexible way of delivering mindfulness training. These technologies can also enable mindfulness training to be tailored to meet an individual needs. Thus, mobile apps could potentially meet the challenge of delivering mindfulness training to young people. However, there are already more than 600 mindfulness apps in the app store, it is difficult to assess the quality of these apps and there is little evidence of their efficacy.

The overall aim of this PhD research program was to identify high-quality mindfulness-based mobile apps, and test the efficacy of one or more apps. This was accomplished through three studies.

- Study 1 aimed to identify a high-quality mindfulness app from the apps already available in the app store.
- Study 2 aimed to compare the efficacy of a low- and high-quality app identified in Study 1. It was also a pilot study to assess the feasibility of a larger trial.
- Study 3 aimed to test the efficacy of the high-quality mindfulness app identified in Study 1, using a delayed treatment design.

1.5 THESIS OUTLINE

Chapters 2, 3 and 4 review existing literature on youth mental health, mindfulness and e-mental health respectively. Chapter 5 gives an overview of the research program. Chapter 6 presents the first study, which reviews and evaluates the quality of iPhone mindfulness apps. Chapter 7 presents the results of the second study which compared the efficacy of a low- and a high-quality mindfulness app while Chapter 8 presents the results of RCT that tested the efficacy of a high-quality mindfulness app. Chapter 9 contains the general discussion and explores the implications of the research program. Appendices include the survey questionnaires and the scales used in the research program, and documents related to ethics approval.

1.6 SIGNIFICANCE OF RESEARCH

The growing global-crisis of youth mental health poses a range of significant challenges including poor help-seeking rates, high treatment-drop-out rates among those who seek help, the identification of effective and suitable interventions to promote health, prevent and reduce mental illness. This research program attempts to address these challenges by testing an innovative approach to improve young people's wellbeing.

The proliferating number of mobile health apps, the lack of quality guidelines for apps that deliver health interventions and the meagre literature in mHealth raise multiple challenges to researchers in this nascent field. The structured and progressive approach of this research program including a contextual app review, app quality ratings with a reliable rating tool, a pilot trial comparing a low- and a high-quality app and the subsequent main trial of a

high-quality app could serve as a guideline for prospective researchers. Above all, it contributes to the scant efficacy literature on mobile apps for mindfulness.

Chapter 2: Youth mental health

2.1 WELLBEING AND MENTAL HEALTH

Wellbeing research's historical roots dates back to Ancient Greeks who investigated the contents and the means to attain "wellbeing" or "the good life" and has significant contributions from philosophers like Socrates, Plato, Aristotle and many others (Stoll, 2014). These philosophies still form the basis of subjective wellbeing research today (Haybron, 2008). It was the field of psychology that brought empirical research into wellbeing. The works of psychologists like William James catalysed the initial periods of scientific investigation of wellbeing (Stoll, 2014). There are two traditions in wellbeing research: hedonic wellbeing that focuses on pleasant affective response to life and eudaimonic wellbeing that focuses on positive functioning in life (Keyes, Shmotkin, & Ryff, 2002). The hedonic tradition equates mental health to experiencing more pleasant and less negative feelings and having a satisfied life, which are the focus of emotional wellbeing research. The eudaimonic tradition equates mental health with human potential and views it in terms of the capacities of becoming a more fully functioning person and citizen (Keyes, 2006).

Mental health, according to the World Health Organisations (WHO), is a state of wellbeing in which an individual realises his or her own potential, can cope with the normal stresses of life, work productively and fruitfully, and is able to make a contribution to his or her community (Herrman, Saxena, & Moodie, 2005). Often the term 'mental health' is incorrectly used to refer mental ill-health, as mental health services have been mostly concerned with treatment of mental illness (Barry & Jenkins, 2007). But it is more than just the absence of mental illness.

The two-continua model (Figure 2) or the Complete State Model (CSM) of mental health (Keyes & Lopez, 2002) presents mental illness and mental health as two separate but related dimensions. Complete mental health, according to CSM, is a combination of high levels of emotional (positive affect, quality of life, life satisfaction), social (social integration, social contribution, social coherence, social actualization, and social acceptance), and psychological (self-acceptance, personal growth, purpose in life, positive relations with others, autonomy, and environmental mastery) wellbeing as well as low levels of mental illness symptoms (Keyes, 1998; Ryff, 1989). Keyes (2002) distinguishes *flourishing* as a high-level emotional well-being state combined with optimal levels of psychological and

social functioning, from *languishing* which is characterised by low levels of these features. Those who are not languishing or flourishing are considered to have moderate mental health (Westerhof & Keyes, 2010).

This hypothesis has been supported by empirical findings in Australian young people, US adolescents, Dutch adults and South African adults (Hides et al., 2016; Westerhof & Keyes, 2010). Gains and losses in mental health were found to predict declines and increases

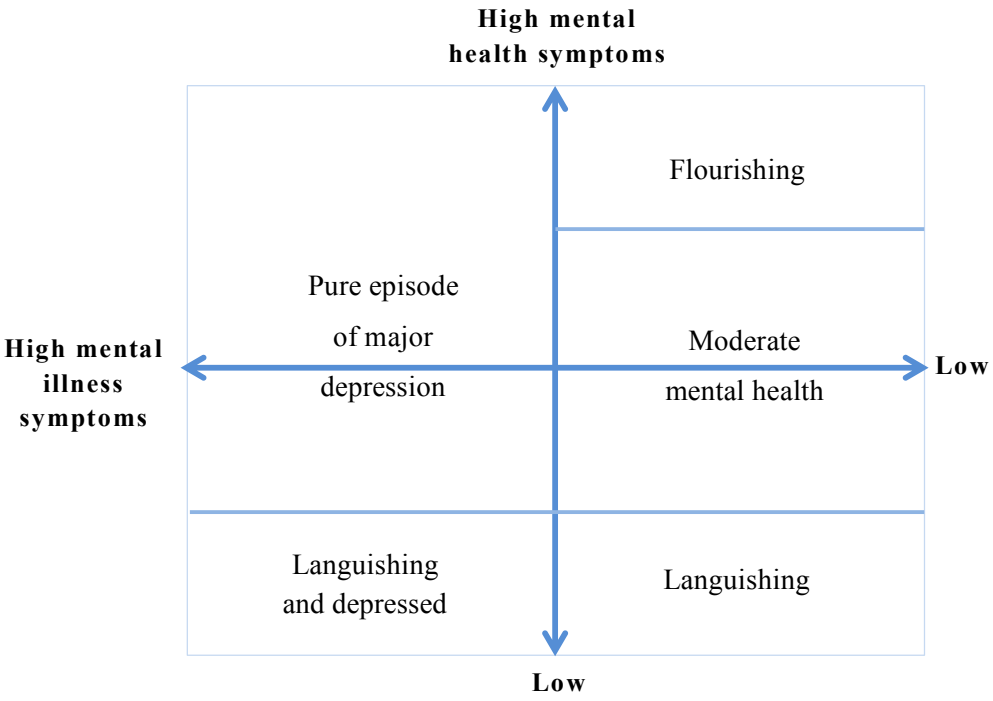

Figure 2 The complete mental health model and diagnostic categories
Adapted from Keyes (2010)

in mental illness respectively (Keyes, Dhingra, & Simoes, 2010). It is critical to note that the level of mental wellbeing distinguishes level of functioning among individuals with or without mental illness (Keyes, 2006, 2007, 2013; Keyes et al., 2010; Provencher & Keyes, 2011; Westerhof & Keyes, 2010). However, the existing health care systems across the globe mostly focus on physical and mental illness (Layard & Clark, 2015), ignoring the importance of mental wellbeing and its promotion for a healthier society (S. Hardy & Thomas, 2012; A. Morgan & Ziglio, 2010). Parity of esteem between mental and physical health is yet to be achieved and is critical (Layard & Clark, 2015; Smith & Wessely, 2015). The need to reform the current health care systems requires innovative approaches at different stages of intervention development and delivery.

2.2 THE PROBLEM

There are 1.8 billion young people between the ages of 10 and 24 years, constituting nearly 25% of the world's population (Gupta et al., 2014). In any given year, 20% of young people between the ages of 15 and 24 experience a mental health problem, most commonly depression or anxiety (Gupta et al., 2014; WHO, 2013a). The rate of depression increases significantly between the ages of 13 and 18, with 11% of the young people experiencing a depressive disorder by the age of 18 (Gray & Dihigo, 2015). Rates of mental disorders increase across childhood and adolescence, with one in five adolescents reporting mental health problems (Knopf, Park, & Mulye, 2008). The proportion of young people suffering from a mental disorder is fairly stable between age 17 and 21 (Patton et al., 2014). Approximately 8% of boys and 23% of girls in that age group suffered from a mental disorder. Episodes of mental disorder were more common in young adulthood (age 21–29) than mid/late adolescence (age 15–17) (Patton et al., 2014). A striking 50% of adult mental disorders have an onset during or before adolescence (Belfer, 2008).

In a longitudinal study, Patton et al (2014) assessed common mental disorders in a sample of 2032 students (age 14-15; baseline) and at every 6 months interval till 28-29 years of age. Of these participants, 1750 took part at least once in the young adult phase and were included in the final analysis. In the adolescent phase, 29% of the boys and 54% of the girls reported a mental disorder at least once. In the young adulthood phase, 31% of men and 52% women reported a disorder at least once. Of the participants with adolescent disorders, 47% of the male participants and 65% of the female participants had at least one episode in the young adulthood phase. Across the 14-year study period, 38% of male cases and 24% female cases of common mental disorders were first identified in young adulthood. For those with persistent adolescent disorder, the rate of disorder continuity to young adulthood was 55% in boys and 70% in girls. In another longitudinal study that assessed 1420 participants from 11 counties in the south eastern United States for anxiety disorders between ages 9 and 26 years, there were increasing levels of prevalence (at least 1 anxiety disorder) from early adolescence to young adulthood (Copeland, Angold, Shanahan, & Costello, 2014). The study also found that all childhood anxiety disorders adversely affected at least one adult functional domain (health/financial/educational/social).

The Australian Life Patterns longitudinal study that follows patterns in young people's lives over time found that the mental health of young people has linearly worsened between age 19 and 25 years (Landstedt et al., 2016). The second national survey of mental health and

wellbeing conducted between 2013 and 2014 found an increased prevalence of depressive disorder from 2.1% to 3.2% in the participants aged 4-17 years from 1998 to 2014 (Lawrence et al., 2015). The study also found that young women and girls have poorer mental health than young men and boys.

Disability-adjusted life years (DALYs) are used to measure the burden of diseases. There was a 41% increase (from 182 million to 258 million) in absolute disability-adjusted life years (DALYs) caused by mental, neurological and substance use (MNS) disorders between 1990 and 2010 in general population globally (V. Patel et al., 2015; Whiteford, Ferrari, Degenhardt, Feigin, & Vos, 2015). The proportion of disease burden increased from 7.3% to 10.4%. DALYs from MNS disorders were highest (18·6%) among individuals aged 15–49 years as opposed to 10·4% at all ages combined. A previous study which used 2004 data found that DALYs in 10-24 year olds represented 15.5% of the total DALYs of all ages and identified neuropsychiatric disorders as the main cause of DALYs in this age group (Gore et al., 2011).

2.2.1 HELP-SEEKING ATTITUDES

Despite the high incidence and prevalence of mental disorders in young people, few access the health services available to them (McGorry et al., 2013; Rickwood et al., 2007). In the 2007 Australian survey of mental health and wellbeing, 26% of the Australians aged 16-24 years had a mental disorder (Milnes et al., 2011), but only 13% of affected males and 31% of females had accessed a health service in the previous 12 months. In a large nationally represented sample of American young people aged 18-26 years with a mental disorder (n=22,600), only 20.4%, had accessed mental health outpatient services, 3.6% had accessed inpatient services, and 25.4% has been prescribed psychotropic medication (Miller et al., 2016). More than 63.4% of young people with a serious mental health disorder did not receive treatment.

Negative attitudes about help-seeking for mental health issues are common in young people and have become increasingly negative over the last few decades (Mackenzie et al., 2014). Rickwook et al. (2005) conceptualised a process model of help-seeking that included awareness and appraisal of mental health problems, expression of symptoms and need of support, availability of sources of help and willingness to seek out and disclose to sources. Young people have barriers at each stage of this process in seeking help for their mental health problem. A systematic review of qualitative and quantitative studies identified 13

themes that emerged as barriers in help-seeking in young people (Gulliver, Griffiths, & Christensen, 2010). Stigma, confidentiality and trust, poor mental-health literacy, fear or stress about seeking help, accessibility of the services and considering problems to be too personal were some of the barriers among others (J. Burns, Davenport, Durkin, Luscombe, & Hickie, 2010; Gulliver et al., 2010; Milnes et al., 2011). Of these, stigma (Clement et al., 2015; Gronholm et al., 2015) and poor mental health literacy (Bonabi et al., 2016; Kutcher et al., 2016) are the most prominent.

2.2.2 YOUTH-UNFRIENDLY HEALTH CARE SYSTEMS

Despite the global high-prevalence of mental illness in children and young people, the opportunities to prevent mental illness and promote wellbeing in this population have not been well exploited (Gore et al., 2011). These problems can be characterised as deficiencies in services and their marketing. Though Australia is at the forefront of youth mental health promotion, there are still areas that need improvement: better reach, innovations in youth-oriented services, creation of more supportive environments and better interconnection with other health care (Rickwood, 2011). Furthermore, current health care practices lack a clear focus or a strong emphasis on the multiple, critical, unique and diverse needs of young people (Rickwood, 2011). In particular, the self-reliant and independent nature of young people should be considered for health services to reach this age group effectively (Gulliver et al., 2010; Rickwood et al., 2007).

A youth-friendly health service should be accessible, available, equitable, appropriate and effective (WHO, 2012). The predominantly physical-illness focused health care systems, designed with paediatric/adult split, lack in most youth-friendly factors including accessibility and appropriateness and are inadequate to meet the complex mental health needs of young people (McGorry et al., 2013). The TRACK study in the UK aimed to identify factors that facilitate or impede effective transition between Child and Adolescent Mental Health Services (CAMHS) and Adult Mental Health Services (AMHS) and recommend about the organisations and delivery of services that promote continuity of care (Singh et al., 2010b). The study identified that for most service users the transition from CAMHS to AMHS was poorly planned, executed and experienced (Singh et al., 2010a). Malla et al. (2016) highlight four key issues in the current health care systems including delay in first contact and treatment, the treatment not suitable to the particular stage of illness, and the ineffective transition of services based on age.

2.2.3 IMPLICATIONS

Young people with poor mental health are potentially vulnerable to substance abuse, suicide risk and poor educational achievements (V. Patel et al., 2007). Untreated mental health problems can not only become more severe, but often lead to other difficulties including social withdrawal, the breakdown of family and personal relationships as well as poorer education and employment outcomes (Olesen, Butterworth, Leach, Kelaher, & Pirkis, 2013). Disturbances in mental wellbeing diminish people's capacity to lead a fulfilling life, and incur substantial costs to their families and the community (WHO, 2013a).

There is an urgent need to reform and redesign the current health care system to address the growing challenge of young people's mental health needs (McGorry, 2007; McGorry, Goldstone, Parker, Rickwood, & Hickie, 2014). A recent report on Australian mental health systems estimated a need of additional 8800 mental health professionals by 2027 at a cumulative cost of $9 billion, if the existing system of mental health services is not reformed to address the rising demand effectively (Hosie, Vogl, Hoddinott, Carden, & Comeau, 2014). The report concluded that large investments in mental health promotion as well as mental health prevention and early intervention programs are urgently required to meet the growing mental health needs of young people.

2.3 PREVENTION, PROMOTION AND EARLY INTERVENTION

Most research activity continues to focus on preventing or alleviating mental illness in young people, rather than promoting wellness (A. Morgan & Ziglio, 2010). Alleviating mental illness for clinical population is advocated more than promoting health for all. As exemplified in the definition by the WHO, mental health cannot be regarded as just the absence of illness alone, but involves prevention of illness and promotion of wellbeing. Young people who do not have a mental disorder should not be ignored and left to lead sub-optimal lives. Health promotion has strong principles of empowerment, participation, positive health and social justice (Tremblay & Richard, 2011). Providing conditions in which young people may flourish should be equally important to health policies and service models as the prevention and management of pathology. Promoting positive virtues and strengths not only improves overall human functioning but also reduces symptoms of mental illness (Aspinwall & Tedeschi, 2010; Venning, 2009). As argued by Slade (2010), assessment and treatment of the individuals should change if the goal is promoting wellbeing rather than treating illness. Building resilience in young people at key points of transition – starting school, starting high

school, and finishing compulsory education – has lifelong benefits (Hawkins, Kosterman, Catalano, Hill, & Abbott, 2005).

Major mental health problems can be reduced through preventive interventions (Greenberg et al., 2015). The Penn Resiliency Program (PRP) is one of the most widely researched depression prevention programs, (Gillham, Brunwasser, & Freres, 2008). A meta-analysis of 17 studies found that PRP showed consistent small, but significant effects on depressive symptoms reduction at 6- and 12-month follow-up when implemented as a universal or selective program (Brunwasser, Gillham, & Kim, 2009). The FRIENDS program is a prevention program that can be delivered as a universal or selective intervention. It aims to increase social and emotional skills, promote resilience and prevent anxiety and depression in children and youth (Barrett, Cooper, & Guajardo, 2014). This program, which is grounded in cognitive-behavioral theory (CBT) and positive psychology approaches, was found to reduce anxiety in grade 5 – 7 students in Australia (Lowry-Webster, Barrett, & Dadds, 2001). Reviews of existing prevention programs found that prevention programs are generally effective but have varying effect sizes (Hetrick, Cox, & Merry, 2015; Mendelson & Tandon, 2016). A Cochrane review of studies on depression prevention supported the efficacy of these programs (Merry et al., 2012). Another review of prevention programs targeting children and adolescents reported cognitive-behavioral or interpersonal approaches, and family-based prevention strategies were most helpful (Gladstone, Beardslee, & O'Connor, 2011). Interventions focused on the prevention of suicide, adult and childhood depression and childhood anxiety provide good value for money as they reduce the treatment cost and welfare cost due disability at a later stage (Mihalopoulos, Vos, Pirkis, & Carter, 2011).

New and complementary models for the prevention of mental health problems also include strength-based models such as social-emotional learning (SEL) and positive youth development (Greenberg et al., 2015). For example, the Collaborative for Academic and Social-Emotional Learning (CASEL) approach aims to prevent mental health problems by promoting self-regulation, self-awareness, social awareness, positive peer relationships, and responsible decision-making (Collaborative for Academic & Learning, 2003). Recent research shows that proficiency in each of these five domains of social competence is related to positive academic, behavioral, and mental health outcomes (Durlak, Weissberg, Dymnicki, Taylor, & Schellinger, 2011).

Selective prevention programs in school settings have gathered evidence for effectiveness with substantial effects in multiple studies (Calear & Christensen, 2010;

Horowitz & Garber, 2006; Merry & Spence, 2007; Stice, Shaw, Bohon, Marti, & Rohde, 2009). A prevention-program based on a developmental psychosocial model of resilience enhancement was found to prevent an initial episode of major depression or dysthymia among adolescents (Arnarson & Craighead, 2009). One hundred and seventy-one adolescents (14-15 years) with depressive symptoms or a negative attributional style were randomly assigned to a prevention program or a treatment-as-usual assessment only control group. The prevention program had 14 sessions, with two sessions per week in the first three weeks and then once per week. The program was implemented by school staff and resulted in a significantly lower rate of major depression and dysthymia at post-test and at a 6-month follow-up than did the control group. This study also demonstrated that skills for prevention-program delivery can be developed in school staff, minimising the cost of delivery.

Universal prevention programs have had mixed results (Sklad, Diekstra, Ritter, Ben, & Gravesteijn, 2012). One recent universal prevention study with US high school students randomised 380 students to a cognitive-behavioural program, an interpersonal psychotherapy-adolescent skills training program or no-intervention control (Horowitz, Garber, Ciesla, Young, & Mufson, 2007). The intervention programs had eight 90-min sessions delivered during the regular weekly wellness classes. At post-intervention, both the intervention groups showed significant lower levels of depressive symptoms than the control group. Students with higher pre-test depression scores had the greatest reduction from intervention. The intervention groups did not differ from each other. The PATHS (Promoting Alternative THinking Strategies) curriculum is a comprehensive program that promotes emotional and social competencies, reducing aggression and behavior problems in preschool through elementary school-aged children, while simultaneously enhancing the educational process in the classroom (Kusché & Greenberg, 2012). This innovative curriculum is designed to be used by educators and counsellors in a multi-year, universal prevention model. The curriculum facilitates students' emotional literacy, self-control, social competence, positive peer relations, and interpersonal problem-solving skills. In contrast to the results of the previously cited approaches, a series of trials on the PATHS curriculum has shown significant, modest improvements in prosocial behavior and reductions in aggressive/disruptive behaviours, and depressive symptoms, as well as improvements in executive functions and classroom atmosphere (Kusché & Greenberg, 2012).

2.4 SUMMARY

The current mental health condition of young people needs urgent attention. This population had the highest prevalence and incidence of mental health problems globally. The poor attitudes to help-seeking in young people and the youth-unfriendly nature of existing healthcare systems are major challenges which need to be addressed. Untreated mental health problems adversely affect not only the individual but also family and community bearing economical costs among others.

Mental health is more than just absence of mental illness. Mental health promotion, prevention and early intervention should be prioritised, especially for helping young people to lead a healthier life (Hosie et al., 2014). Mindfulness has the potential to be an effective intervention that can suit young people to both address mental health problems and to promote health (Monshat, Vella-Brodrick, et al., 2012). The next chapter reviews mindfulness and its effectiveness.

Chapter 3: Mindfulness

3.1 INTRODUCTION

Mindfulness has been broadly conceptualized as a state in which one is highly aware of bodily sensations, mental state, feelings and emotions, and focused on the reality of the present moment, accepting and acknowledging it, without becoming caught up in thoughts that are about the situation, or in emotional reactions to the situation (Bishop, 2002; Kabat-Zinn, 1982). It has its conceptual roots in Eastern philosophy, particularly Buddhism, which aims to relieve the suffering of people through practising a spiritual path.

The fundamental teaching of Buddhism, acknowledged by its different traditions involves the Four Noble Truths: (i) Suffering exists, (ii) There is a cause of suffering, (iii) There is a cessation of suffering and (iv) There is a path that leads to the cessation of the suffering (Gordon, Shonin, Griffiths, & Singh, 2014; Shonin & Gordon, 2014). The path comprises eight elements grouped under factors of *wisdom*: (right view, right intention), *ethical conduct*: (right speech, right action, right livelihood), and *mental discipline*: (right effort, right mindfulness, right concentration) (Van Gordon, Shonin, Griffiths, & Singh, 2015). This framework proposes a way for healthy living, to achieve wellbeing and to eradicate suffering. It is important to note that mindfulness and concentration are treated as two distinct aspects of the path, as meditative concentration and mindfulness are often misunderstood to be one (Gordon et al., 2014). The key Buddhist scripture that explains mindfulness, the Sattipattana Sutta, gives instructions to contemplate on mind, body, consciousness and mental objects in a methodical way, to develop and practise mindfulness (Silanada, 1995).

Mindfulness was popularised in the 1950s and 60s by the German scholar monk, Nyanaponika Thera who influenced many modern meditation teachers (Hwang & Kearney, 2015). Jon Kabat-Zinn, a physician, followed this lineage and started teaching mindfulness to his patients in the late 1970s and established a stress-reduction clinic (Hwang & Kearney, 2015; Kabat-Zinn, 2006). Later in 1979 Kabat-Zinn created the mindfulness-based stress reduction (MBSR) program as a model and training vehicle for the relief of suffering and offered the program through the stress-reduction clinic (Kabat-Zinn, 2006). MBSR became an influential mindfulness program that attracted scientific attention and starting gaining empirical evidence to treat stress, depression and anxiety (Grossman et al., 2004). MBSR

methodologically teaches people to "mindfully" respond to stressful situations than to react automatically.

In the mid-1970s, another perspective on mindfulness emerged in the western scientific world through the work of Ellen Langer, a cognitive scientist (Langer & Moldoveanu, 2002; Pagnini & Philips; Riskin, 2014). This was referred as Langerian or socio-cognitive mindfulness in some literature (Fatemi, 2014; Langer, Pirson, & Delizonna, 2010; Riskin, 2014). Langer (1992) describes mindfulness as a process of drawing novel distinction, which keeps us situated in the present. It is a state of conscious awareness, through which a person gets a new perspective on the context and the content of the information, without relying on the distinctions and categories drawn from the past experience. Mindfulness is compared against mindlessness, which is characterised by over-reliance on the past experience, where the individual is oblivious to the novel aspects of the situation. She argues that mindfulness leads to diverse positive consequences, including greater sensitivity, openness, enhanced awareness, and creation of new categories for structuring perception (Langer & Moldoveanu, 2002). Though the two perspectives are different, they overlap in the ideas of present-moment focus and developing sensitivity and curiosity to experiencing the present moment (Pagnini & Philips, 2015). This research program follows the Buddhist-inspired mindfulness which is the foundation for mindfulness-based interventions (Kabat-Zinn, 2011; Williams & Kabat-Zinn, 2011).

Though traditionally mindfulness was a part of a broader spiritual framework, contemporary science started investigating mindfulness as a separate phenomenon. The conception of MBSR was one reason for this development, as Kabat-Zinn stripped mindfulness of the religious, cultural and ideological factors associated with its Buddhist origins, to make MBSR a secular program for wider reach and acceptance (Kabat-Zinn, 2006). According to Kabat-Zinn (2006), mindfulness is "paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experience moment by moment".

While Kabat-Zinn's definition is widely accepted, there is no standard scientific definition of mindfulness (Chiesa, 2013). There are multiple descriptions of mindfulness. Bergomi et al. (2013) reviewed published mindfulness scales and identified nine aspects of mindfulness: (i) observing, attending to experiences, (ii) acting with awareness, (iii) nonjudgment/acceptance of experiences, (iv) self-acceptance, (v) willingness and readiness to expose oneself to experiences/non-avoidance, (vi) non-reactivity to experience, (vii) non-identification with own experiences, (viii) insightful understanding, and (ix)

labelling/describing. Mikulas (2011) describes mindfulness as a construct comprising concentration, awareness, insight, attitude and awakening, and emphasises the importance to make distinctions between the contents and the behaviour of the mind. Another description distinguishes two facets of mindfulness: present-centred attention and acceptance of experience (Coffey et al., 2010). Grabovac et al. (2011) propose a Buddhist psychological model of mindfulness, which describes it in terms of sense impressions, mental events and habitual reactions. These diverse definitions can be seen as compatible descriptions of a single complex phenomenon.

With an effort to give an operational definition, Bishop et al. (2004) arrived at a two-component model of mindfulness. The first involves self-regulation, while the second involves orientation to one's experiences in the present moment. Bishop et al. (2004) view mindfulness as "a process of regulating attention in order to bring a quality of non-elaborative awareness to current experience and a quality of relating to one's experience within an orientation of curiosity, experiential openness, and acceptance" (p. 234). They also note that it is a process of gaining insight into the nature of one's mind, and the adoption of a 'de-centered' (or distanced) perspective (Safran & Segal, 1996) on thoughts and feelings, so that they can be experienced in terms of their subjectivity (versus their necessary validity) and transient nature (versus their permanence). Bishop et al. also argue that mindfulness is a skill that can be developed by practice.

The clinical application and empirical evidence of MBSR has led to the development of many mindfulness-based interventions. Mindfulness-based cognitive therapy (MBCT) adapted the theoretical framework of MBSR to prevent relapse in depression (Teasdale, Segal, & Williams, 2006). Dialectical Behaviour therapy (DBT) was designed to treat people with borderline personality disorder (Robins, Ivanoff, & Linehan, 2001). Acceptance and commitment therapy (ACT) is a flexible therapy that includes mindfulness exercises to treat varied conditions including depression, anxiety, alcohol and drug use (Hayes, Luoma, Bond, Masuda, & Lillis, 2006). These interventions are researched widely, and their initial results are promising.

3.2 MINDFULNESS EFFECTS

Mindfulness has been found to have salutary psychological, somatic, behavioural, and interpersonal effects (Brown, Ryan, & Creswell, 2007), developing personal qualities such as a non-judgemental, non-striving perspective, acceptance, patience, trust, openness, letting go,

gentleness, generosity, empathy, gratitude and loving-kindness, each of which are relevant to the personal recovery of people with mental disorders, as well as to positive wellbeing in general (M. Slade, 2010). Though the thesis focusses on wellbeing of young people, mindfulness literature in general population are also reviewed to establish the effectiveness of mindfulness. Moreover, until recently mindfulness has gained more empirical evidence for adult population than youth in both clinical and non-clinical setting (Tan, 2015).

3.2.1 CLINICAL OUTCOMES

A meta-analysis based on 39 studies totalling 1,140 participants from clinical sample (with diagnosable psychological or physical disorder) with age range 18 – 65 years found that mindfulness-based therapy was moderately effective for improving anxiety (g = 0.63) and mood symptoms (g=0.59) from pre- to post-treatment in the overall sample (Hofmann, Sawyer, Witt, & Oh, 2010). The intervention was found to have large effect sizes in patients with anxiety (g= 0.97) and mood disorders (g=0.95). These effect sizes, irrespective of the time of the study, were robust and were maintained over follow-up. A meta-analysis (Chiesa & Serretti, 2011) of 16 controlled trials that investigated the efficacy of MBCT for patients suffering from psychiatric disorders (delivered as an adjunct to usual care) resulted in significantly larger reductions in major depression (MD) relapses in patients with three or more prior depressive episodes. Khoury et al. (2013a) conducted a comprehensive effect-size analysis to evaluate the efficacy of mindfulness-based therapy and found that it is an effective treatment for a variety of psychological problems especially for reducing anxiety, depression, and stress. They included a total of 209 studies (n = 12,145) from the first available date until 10 May 2013. Mindfulness-based therapy was found moderately effective in pre-post comparisons (n = 72; g = .55), in comparisons with waitlist controls (n = 67; g = .53), and when compared with other active treatments (n = 68; g = .33), including other psychological treatments (n = 35; g = .22).

MBSR was compared with CBT (training to change pain-related thoughts and behaviours) and treatment as usual (TAU) for adult patients with chronic low back pain in a recent RCT (Cherkin et al., 2016). Participants (n = 342; M age = 49, SD = 12.3) were randomly allocated to receive MBSR (n = 116), CBT (n = 113), or usual care (n = 113). Participants attended a weekly 2 hour MBSR or CBT groups for 8 weeks or received TAU. Both intervention groups achieved significantly greater improvements in back pain and functioning limitations at 26 weeks than those in usual care. No significant differences in the outcomes of the MBSR and CBT groups were found. In Goldin et al. (2016), 108 un-

medicated patients with social anxiety disorder (SAD) (M age = 32.7 years, SD = 8.0) were randomised to 12 weeks (2.5 hour session)s of cognitive–behavioral group therapy (CBGT; n = 36), MBSR (n = 36) or waitlist (n = 36) groups and completed assessments at baseline, posttreatment and at 1-year follow-up (Goldin et al., 2016). The MBSR group followed the standard MBSR curriculum with an additional 4 weeks of sessions to match CBGT. CBGT and MBSR both produced greater improvements in social anxiety symptoms, cognitive reappraisal frequency and self-efficacy, cognitive distortions, mindfulness skills, attention focusing, and rumination than the waitlist group. As in the previous study, MBSR results were comparable with those from CBGT.

Eisendrath et al. (2016) randomised 173 patients with major depressive disorder to MBCT (n = 87) or a health enhancement program (HEP; n = 86). The health enhancement program was comprised of physical fitness, music therapy and nutritional education. MBCT significantly decreased depression severity and improved depression treatment response rates at 8 weeks compared to the HEP group. Kuyken et al. (2015) randomly allocated 424 adults (M age 50) who were diagnosed with recurrent major depressive disorder and were on a therapeutic dose of maintenance antidepressant drugs to receive either maintenance antidepressant treatment (n = 212) or an 8-week MBCT class that included support to taper or discontinue their maintenance antidepressant medication (n = 212) and found MBCT as an alternative to antidepressants for prevention of depressive relapse or recurrence at similar costs. Both treatments were associated with enduring positive outcomes in terms of relapse or recurrence, residual depressive symptoms, and quality of life. Mindfulness training has also been used to address bipolar disorder. Elices et al. (2016) randomised 64 participants diagnosed with bipolar disorder (BPD; M age = 31.64, SD = 6.9) to 10 weeks of mindfulness (n = 32) or interpersonal effectiveness skills training (n = 32). BPD symptoms and mindfulness capacities were measured at pre- and post-intervention. The mindfulness group experienced a significantly greater reduction in BPD symptoms and increase in their de-centering capacity (ability to step back and observe events in a detached manner). Treatment response rates (in reference to BPD symptoms) were also higher for the mindfulness participants (40% vs. 13 %). These results suggest that mindfulness training may be a useful approach to decreasing BPD symptoms while simultaneously improving mindfulness capacities. In a pragmatic randomised controlled trial, males (n = 180; age >= 18 years) with co-occurring substance use and psychiatric disorders, as well as extensive trauma histories, were randomly assigned to 10 weeks of group treatment with an MBI, Mindfulness-Oriented

Recovery Enhancement (MORE; n = 64), CBT (n = 64), or TAU (n = 52) (Garland, Roberts-Lewis, Tronnier, Graves, & Kelley, 2016). At post-treatment, MORE was associated with modest yet significantly greater improvements in substance craving, post-traumatic stress, and negative affect than CBT, and greater improvements in post-traumatic stress and positive affect than TAU at post-treatment.

3.2.2 NON-CLINICAL OUTCOMES

Sharma et al. (2014) conducted a meta-analysis on 17 studies on MBSR among healthy adults (age > 18 years) published between January 2009 and January 2014. Sixteen of the studies demonstrated positive changes in psychological or physiological outcomes related to stress/anxiety. Though the analysis had limitations, as not all of the included studies were RCTs, the results supported MBSR as a promising modality for reducing stress/anxiety. Another meta-analysis of 39 studies published before March 2010 which evaluated mindfulness-based interventions or just mindfulness meditation (e.g. Vipassana, Zen meditation) among non-clinical adult populations found MBSR had strong effects in reducing stress and improving psychological wellbeing (Eberth & Sedlmeier, 2012). These results were supported by a recent meta-analysis on the efficacy of MBSR in non-clinical populations (Khoury et al., 2015). Twenty-nine studies published before 19 September 2014 were included. MBSR was moderately effective in reducing stress, depression, anxiety and distress and in ameliorating the quality of life of healthy individuals.

3.3 YOUTH AND MINDFULNESS

A 2014 systematic review and meta-analysis that evaluated the quality and effectiveness of MBIs in treatment of mental health problems in clinical and non-clinical setting among children and adolescents identified 15 RCTs (Kallapiran, Koo, Kirubakaran, & Hancock, 2015). The results supported the effectiveness of MBIs for improving the mental health symptoms of children and adolescents. The age range of the participants in these studies varied from 8 to 20 years and 8 of the studies included participants who were above 16 years of age. Seven of the studies had at least 50 participants. The reviewers included yoga as an MBI as it has significant mindfulness component in its practice (Khanna & Greeson, 2013). This high quality review grouped the RCTs based on the interventions, control (active or inactive), and the use of clinical or non-clinical populations. MBIs based on MBSR/MBCT (n = 659) compared to non-active treatment were found to be more effective in reducing stress (g = 0.31; 3 studies), anxiety (g = 0.96; 3 studies), and depression (g = 0.42; 2 studies) in non-

clinical population. ACT (n = 263) was comparable to active treatments in managing anxiety (g = 0.02; 1 study), depression (g = 0.57; 3 studies) and quality of life (g = 0.38; 2 studies) in clinical populations. Other MBIs (n = 196) included in the review were significantly more effective in improving stress symptoms (g = 0.67; 2 studies) and anxiety (g = 0.87; 2 studies) but not depression in non-clinical population compared to non-active controls.

A previous meta-analysis identified 13 randomised controlled trials and seven uncontrolled studies on the efficacy of MBIs for young people under the age of 18 (during initial assessment) published between 2004 and 2011 (Zoogman, Goldberg, Hoyt, & Miller, 2014). This review excluded ACT and DBT. Five of the 13 RCTs were included in the later review by Kallapiran (2015) discussed earlier. The analysis found a universal, non-specific effect of mindfulness compared to active control treatments. Though the primary omnibus effect size was small (Becker's (1988) *del = .227*) it supported the superiority of mindfulness interventions over the active control groups. The analysis identified a significantly larger effects on psychological symptoms compared to other outcome variables (*del*: 0.37 vs 0.21, p = .028) and among clinical compared to non-clinical populations (*del*: 0.50 vs 0.20, p = .024). No other significant moderators of intervention effects were identified (e.g., outside practice, instructor experience, session length, treatment frequency, length, type). In summary, evidence from systematic reviews and meta-analyses conducted to date provides broad support for the use of MBT in young people, despite considerable heterogeneity in the sample, type of MBT and outcome measures used in research to date. Although the majority of participants in the studies included in these reviews and meta-analysis were under 18 years of age, there is some overlap with the age group (16-25 years) being used in this PhD.

Multiple studies have demonstrated the efficacy of mindfulness training in college students, especially for reducing stress (Christopher, Charoensuk, Gilbert, Neary, & Pearce, 2009; Murphy, 2006; Shapiro, Oman, Thoresen, Plante, & Flinders, 2008; Warnecke, Quinn, Ogden, Towle, & Nelson, 2011). For example, a recent study randomised 50 nursing students were randomised to MBSR (n = 21) or an 8 week waitlist control (n = 23) (Song & Lindquist, 2015). The MBSR group achieved significantly greater decreases in depression, anxiety and stress, and a greater increase in mindfulness at 8 weeks follow up than the waitlist control group. No post intervention follow-up was conducted, which limited the study from reporting if the effects sustained. Forty students attending a technical college in Thailand who received a mindfulness meditation intervention showed improved self-regulation and self-awareness compared with the 56 students who were in a no-intervention control group (Wongtongkam,

Ward, Day, & Winefield, 2013). Tang et al. (2007) assigned 40 Chinese undergraduates to 5 days of integrative body mind training, which included breathing techniques and mindfulness practices, and 40 students to a control group which received relaxation training. The experimental group had significantly greater improvements in attention and self-regulation post-intervention.

Mindfulness training has also been found to be negatively associated with self-harm in young people and positively associated with cardiovascular and psychological health in young people (Batey, 2011; Prazak et al., 2012). Multiple research studies have demonstrated that mindfulness training is feasible in young people, reduces psychological distress and also optimizes psychological functioning (Burke, 2009; Coffey et al., 2010; Greenberg & Harris, 2012; Monshat, Vella-Brodrick, et al., 2012; Murphy, 2006; M. Thompson & Gauntlett-Gilbert, 2008).

The feasibility of delivering age-appropriate mindfulness training techniques to young people has been well established and there is mounting evidence for its positive impacts on psychological outcomes, especially stress, anxiety and emotional regulation and academic performances (Coholic, 2011; Mendelson et al., 2010; Monshat, Khong, et al., 2012; Zelazo & Lyons, 2011, 2012). As a result, MBIs have been widely adopted in school settings. A trial in a school setting with 155 students (age 14-15) found a positive association between mindfulness practice and psychological wellbeing in the mindfulness training group compared to a no intervention control group (Huppert & Johnson, 2010). A 6-week school-based mindfulness trial in Hong Kong among 48 students (age 14-16), found a mindfulness program resulted in greater reductions in depressive symptoms and increased psychological wellbeing compared with a no-intervention controls (Lau & Hue, 2011). A trial by Raes et al. (2013) of a group mindfulness program with 408 students (age 13-20), also found a significantly greater reduction in depression in the mindfulness condition than in no intervention control condition, both immediately after the intervention and at 6-month follow-up.

3.4 SUMMARY

Mindfulness practice is a significant component of the Buddhist spiritual framework that accepts and guides the alleviation of suffering. MBSR was Kabat-Zinn's pioneering program that imbibed secular mindfulness into western science and has gained substantial evidence on its beneficiary effects on health outcomes. The efficacy outcomes of MBSR led to the development of other MBIs (e.g., MBCT, ACT, and DBT) that are gaining evidence for

improving health conditions. Another indicator of the popularity of mindfulness is the rise in the number of published RCTs from 11 in 2000-2003 to 237 in 2012-2015 (Creswell, 2016). Most MBIs have demonstrated effectiveness in both clinical and non-clinical populations for improving multiple psychological symptoms, especially stress, depression and anxiety. Mindfulness interventions are found suitable for prevention, promotion and early intervention. Mindfulness is increasingly adapted for prevention programs among school aged population. While most prevention programs targeted school aged population, young people (16-25), being most vulnerable to mental illness would benefit from such prevention programs. While MBIs were mostly tested on adult populations, evidence of their effects on young people is growing.

This thesis aims to address the mental health problems of young people in the age range 16-25 years of age, the group with the highest prevalence and incidence of mental health problems. While the majority of research in youth populations has been conducted with adolescents aged under 18 years, there is some overlap with the age group (16-25 years) used in this PhD.

The substantial evidence for the efficacy of MBIs and its proven adaptability, acceptability and feasibility among young people increases its potential to address the growing mental health concerns of this group. However, the traditional face-to-face method of delivering MBIs limits the accessibility and adaptability of this high-potential intervention. E-mental health provides a promising and scalable method for delivering mindfulness training to the large numbers of young people with mental health problems.

Chapter 4: E-mental health: Mobile Apps

4.1 INTRODUCTION

Information and communication technology is increasingly used in health care, especially in mental health. E-mental health (eMH) is the use of information and communication technologies (ICT) to support and improve mental health, including the use of online resources, social media and smartphone applications (Christensen et al., 2014; Cotton

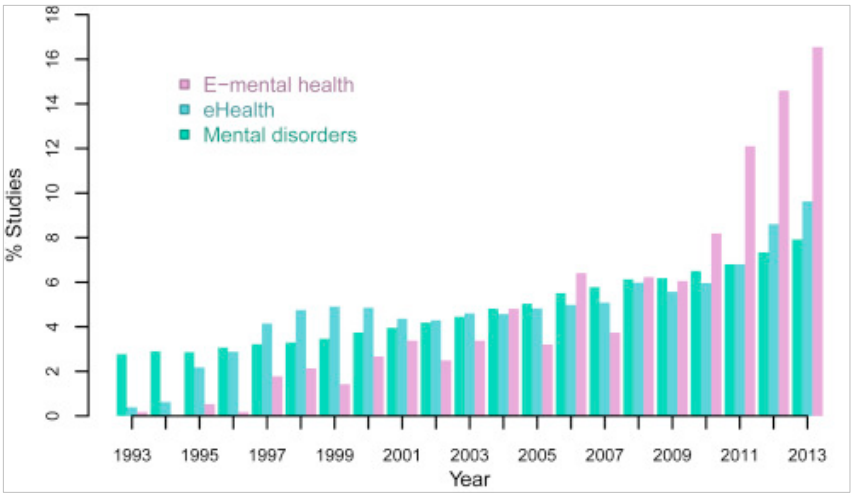

Figure 3 Proportions of research published overtime

et al., 2013; Klein et al., 2014). There is a significant increase in the number of eMH articles published since 1993 (Figure 3) (Firth, Torous, & Yung, 2016) with growing efficacy evidence (Meurk, Leung, Hall, Head, & Whiteford, 2016). Lal et al. (2014) identified eMH addressing four areas in mental health service delivery: information provision; screening, assessment, and monitoring; intervention; and social support. eMH services are highly accessible, flexible and cost-effective (Lal & Adair, 2014).

E-mental health applications provide an highly acceptable and effective method for delivering mental health treatment to young Australians (Christensen & Hickie, 2010b). Online interventions for a range of mental disorders and problematic health behaviours have demonstrated effectiveness. Internet-delivered cognitive behavior therapy (ICBT) has been tested in a growing number of trials and found to have equivalent effects to face-to-face treatment (Andersson, Cuijpers, Carlbring, Riper, & Hedman, 2014; Christensen, Griffiths, & Jorm, 2004). Online interventions are suitable for delivering self-help and peer-support, and virtual groups and clinics using assisted professional care can potentially reduce the costs of

at all levels of health care within a stepped-care model (Doherty, Coyle, & Matthews, 2010). While most evidence for eMH exists for internet interventions (Meurk et al., 2016), mobile apps are starting to gain attention (Moore, Depp, Wetherell, & Lenze, 2016; J. Torous & Baker, 2016).

There is a rapid growth of smartphone usage worldwide, with more than 3.2 billion unique mobile users (Steinhubl, Muse, & Topol, 2013). Smartphone ownership in Australia has been steadily increasing since 2011, 89% of participants (age 18-75) in a recent survey owned a smartphone (Mackay, 2014), 88% of whom reported using the smartphone for accessing internet. Smartphones have internet connectivity and computing capabilities to run apps, in addition to standard text and voice communication facilities (Boulos, Wheeler, Tavares, & Jones, 2011). There are more than 1.5 billion apps in each of the major app stores, Apple app store and Google play (Figure 4) (Statista, 2016).

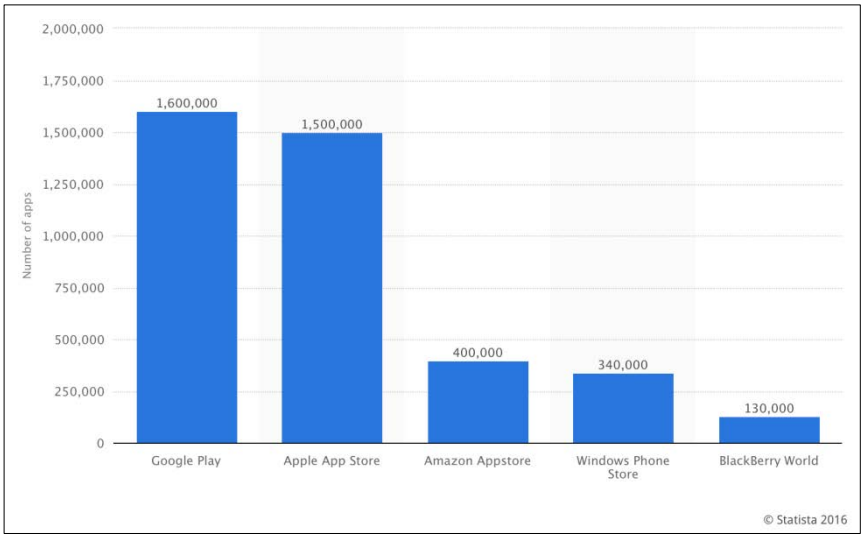

Figure 4 Number of apps in the leading app stores

App downloads worldwide have been steadily increasing: While there were 2.52 billion downloads in 2009, they are expected to reach 268.69 billion in 2017 (Statista, 2016). This phenomenal growth in smartphone uptake and mobile apps, and the concurrent development of increasingly sophisticated sensors and other wireless technologies offer substantial opportunities for leverage by health care services. Smartphones and apps offer privacy, flexibility and reduce the barrier of distance (Price et al., 2014), which can be extremely beneficial to remote delivery of interventions.

This use of smartphones, sensors and other related technologies in health care services has led to the development of mobile health (mHealth). This phenomenon is an offshoot of already established eHealth methods, which have used web-based delivery of health information and related interventions. The World Health Organization's Global Observatory for eHealth (GOe) defines mHealth as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices" (Kay, 2011). Catalysed by the rapid technological development of wireless communication, it is fast becoming an essential component of global health service delivery (mHealth Alliance, 2013). mHealth has been used in the field of medicine since the 1990s (Luxton, McCann, Bush, Mishkind, & Reger, 2011), but has received more attention in relation to physical health and lifestyle domains than in mental health (Free et al., 2013; Harrison et al., 2011; Payne, Lister, West, & Bernhardt, 2015). While most evidence for eMH exist for internet interventions (Aboujaoude, Salame, & Naim, 2015; Meurk et al., 2016), mobile based delivery of interventions need more evidence (Christensen & Petrie, 2013; Dalkou, Nikopoulou, & Panagopoulou, 2015; Price et al., 2014; Steinhubl et al., 2013).

4.2 EFFICACY

A systematic review of health intervention apps conducted in September 2014 identified 24 apps (Payne et al., 2015). Fourteen of the apps involved interventions for physical activity and diet, four diabetes management and two addictions. Only four studies were related to mental health. Of the four, only two were randomised controlled trials. The review reported most studies were feasibility or pilot studies with small sample sizes but with positive outcomes in behaviour change, warranting a need for rigorous research. Mobile apps were highly acceptable as an intervention medium among the small samples in the studies.

A randomised controlled trial on impact of ‘myCompass’, a mobile-friendly web-based program, found significant improvement in symptoms of depression, anxiety, stress and work and social functioning (between-group effect sizes ranged from d = .22 to d = .55 based on the observed means) among a community sample (n = 720; M age = 38.5; age 18–75) compared to attentional control and waitlist control conditions over 7 weeks (Proudfoot et al., 2013). ‘myCompass’ is a fully-automated, self-help, public health intervention without therapist involvement. Users can monitor their symptoms in real-time using their mobile phone or computer and can set reminder alerts delivered regularly via SMS or email. A parallel two-group RCT evaluated a responsive web-app “MoodHacker” for reducing

depressive symptoms and negative cognitions, and increasing behavioural activation, knowledge of depression, and functioning in the workplace among 300 adult employees (age 18-45) who had mild to moderate depression (Birney, Gunn, Russell, & Ary, 2016). Participants were randomised to use "MoodHacker" web app (n = 150) or alternate websites with information on depression. The intervention group showed significant reduction in depressive symptoms pre-test to 6-week follow-up (partial eta^2 = .021) compared to the other group. Improvements for the other outcome measures were also significant from pre-test to 6-week follow-up. Only work absence measure retained significant effect at 10-week follow up while the other outcome measures did not. Though the researchers addressed "MoodHacker" as a mobile web-app, participants were allowed to access the service through their mobile or desktop. The study did not have a no-treatment control group and the comparison group accessed depression related websites. While the results of the study are positive, these limitations restrict its evidence.

A clinical trial was carried out on the effectiveness of a mobile phone application (mobiletype) with 114 young people (age 14-24) (Reid et al., 2011). Mobiletype monitors mood, stress, alcohol use, patterns of daily activities like eating, sleeping, exercise and sends the data for review to the participants' General Practitioners (GPs). The trial had promising outcomes, like increased emotional self-awareness and the practitioners involved in the trial gave positive feedback on the usage of mobile phones for health interventions. Watts et al. (2013) conducted a pilot randomised controlled trial to determine the efficacy of mobile phone as a delivery medium of a previously validated computerised program (The Sadness Program). The program was modified to a mobile iPhone/iPad app (Get Happy). Out of 35 participants who were above 18 years of age (M age = 41), 15 used the "Get Happy" app and the rest used "Sadness Program" over a period of 8 weeks. At post-treatment and at the 3-month follow-up, both groups showed a similar significant decrease in depression.

In a study on the use of mobile phones to promote wellbeing in an unselected sample, Preziosa et al. (2009) divided 90 rail commuters aged 20-25 randomly to three conditions: mobile narratives of a similar trip through mobile phones, commercial videos of new age music and no treatment. The mobile narratives group experienced significant reduction in anxiety levels and higher level of engagement and a feeling of presence. While participants were only tracked for 2 days, this study with its limitations supports the efficacy of the mobile phones as relaxation tools.

In a quasi-experimental study, Rizvi et al. (2011) found "DBT Coach", a mobile app to help generalise 'opposite action' DBT skills, to be effective among 22 people (M age = 33) with borderline personality disorder and a comorbid substance use disorder. The participants used the app for 10-14 days, and showed decreases in emotion intensity and urge to use substances after each coaching session provided by the app. These studies show that mobile apps potentially can be an effective tool for delivering health interventions (Boschen & Casey, 2008).

Mobile messaging services such as short message service (SMS) and multimedia messages are increasingly being used to cue self-management, and have been found to be effective supports to health interventions in clinical settings (Free et al., 2013; Obermayer, Riley, Asif, & Jean-Mary, 2004). For example, appropriate self-tailored mobile text and video messages to intervention group improved smoking cessation compared to control group that received generic health messages (Free et al., 2009; Naughton, Prevost, Gilbert, & Sutton, 2012; Whittaker et al., 2011) and mobile text messages as reminders increased the adherence to antiretroviral therapy in adult patients compared to beep alerts (H. Hardy et al., 2011).

Mobile delivery of CBT has preliminary evidence for acceptance and efficacy (Dagöö et al., 2014; Koffel et al., 2016). Supplementing cognitive-behavioural therapies with smartphone interventions can potentially increase their impact, both by improving self-monitoring (Cook, Biyanova, Elhai, Schnurr, & Coyne, 2010; Eonta et al., 2011) and cueing the application of coping strategies identified in treatment sessions. Preliminary studies of mobile therapy based on CBT show promise (M. N. Burns et al., 2011; Morris et al., 2010). Individuals used mobile therapies creatively to increase self-awareness, cope with diverse stressors, and empathize with others (Morris et al., 2010). Mobile apps can help with personal homework prescribed by clinicians. An exploratory pilot study with eight participants examined the potential of smartphone to broaden access to CBT therapy skills like emotional awareness and self-regulation and found promising results (Morris et al., 2010). Participants understood the concepts delivered through the smartphone app, learned quickly to map their moods using the app and reported improved emotional awareness and self-regulation. As interventions related to CBT are more commonplace and found effective for youth, mobile apps technology to deliver them should be further explored (Kay, 2011).

At present, there are more controlled trials on health interventions using mobile messaging services (Free et al., 2013) than mobile apps (Demir, 2012; Gurman, Rubin, & Roess, 2012; Kratzke & Cox, 2012; K. Ly, 2011; Maheu, Pulier, McMenamin, & Posen,

2012; Melnik, 2011). Most existing studies support the feasibility of mobile phones and apps as an intervention medium through pilot randomised controlled trials, suggesting the need for further full-fledged trials (Ehrenreich, Righter, Rocke, Dixon, & Himelhoch, 2011; Gurman et al., 2012; Martin, 2012; McCurdie et al., 2012).

4.3 MINDFULNESS APPS

Mindfulness training through online media appears to be an acceptable and promising approach. Multiple trials of web-based mindfulness training have found significant reductions in depression, anxiety and stress symptoms (Cavanagh et al., 2013; Kemper & Yun, 2015; Krusche et al., 2013; Laurie & Blandford, 2016; Mak et al., 2015; Messer et al., 2016; Morledge et al., 2013; Boettcher et al., 2014). A recent meta-analysis to estimate the overall effects of online MBIs on mental health (Spijkerman, Pots, & Bohlmeijer, 2016) that included 15 randomised controlled trials found small but significant beneficial impact on depression ($g = 0.29$), anxiety ($g = 0.22$), well-being ($g = 0.23$) and mindfulness ($g = 0.32$) using a random effects model to compute pre-post between-group effect sizes. Guided online MBIs had significantly higher effect sizes than unguided MBIs. The mean age of the participants of the studies ranged from 18 to 58 years. The studies used MBSR, MBCT or ACT interventions. The findings indicate that online MBIs have potential to contribute to improving mental health outcomes, particularly stress.

An internet-delivered mindfulness training to university students reduced stress with large effect size validating the effectiveness of online delivery of mindfulness training (Messer et al., 2016). An uncontrolled study of a thought distancing app (AEON) that employed 'research in the large' approach of a mindfulness app found a significant increase in mindfulness levels of participants ($n = 136$, M age = 37.85) over 4 weeks (Chittaro & Vianello, 2016). The app was well received and was found to elicit positive feelings in users. In an earlier lab experiment, the app was found to have better results among people with no or minimal experience with meditation, in terms of achieved mindfulness and perceived levels of difficulty, compared to traditional methods of practice (Chittaro & Vianello, 2014). Mobile phone applications (apps) have advantages of increased flexibility and convenience (Meeker, 2016), and may provide a viable medium for mindfulness training.

Only three trials have examined the efficacy of mindfulness apps (Carissoli, Villani, & Riva, 2015; Howells, Ivtzan, & Eiroa-Orosa, 2014; Ly et al., 2014), none of which focused on young people. A randomised controlled trial of the 'Headspace On-The-Go' app among a

self-selected sample of adults recruited online (n = 194, M age = 40.7 years), found those who received the mindfulness app (n = 57) had significantly greater increases in positive affect and decreases in depressive symptoms over 10 days of app use than controls (n = 64) who logged their activities in a generic app (Howells et al., 2014). However, no differential changes in negative affect, flourishing or satisfaction with life were found. Another randomised controlled trial (Carissoli et al., 2015), encouraged Italian adult volunteers (n = 56, M age = 38) to use a mindfulness app (''It's time to relax!'') or listen to relaxing music on their mobile for 18 days. A third group received no treatment over the period. No differential changes in self-reported stress were seen between the three experimental conditions at post-intervention. Both the trials only assessed outcomes at post treatment (10-18 days) and neither trial pre-selected participants with distress.

The other controlled trial randomised Swedish volunteers (n = 81, M age = 36) suffering from major depressive disorder to a behavioural activation (n = 40) or mindfulness (n = 41) app delivered over 8 weeks (Ly et al., 2014). The intervention included relevant web-based psychoeducation prior to app use and a maximum time of 20-minute weekly therapist contact per participant. There was no significant difference between the two interventions at post-treatment or at 6-month follow up, but large within-group reductions in depressive symptoms were found in both conditions. However, the absence of a no-treatment control condition weakens the findings.

The potential of apps to deliver mindfulness training efficiently and the efficacy of the apps to produce positive health outcomes are yet to be explored and researched well.

4.4 YOUTH AND TECHNOLOGY

Technology has the potential to cater to the complex health care needs of young people including adolescents, who are a non-homogeneous group (WHO, 2012). It already plays a significant role in the day-to-day life of young people (Montague, Varcin, Simmons, & Parker, 2015), and this group already constitutes major users of self-help and web-based information. A recent cross-sectional study of 1400 young people (16-25 years) found that 99% of the participants used the internet and 95% on a daily basis (J. Burns et al., 2015), with an average of 3.4 hr reportedly being spent using technologies. Young people are also more confident in learning technologies than older adults (Parsons, 2015).

Many studies have demonstrated the high acceptability of mobile app intervention among young people. For example, an uncontrolled pilot study involving 20 adolescents (age

12-16) using a mHealth app for iPhone/iPad (bant) for type 1 diabetes self-management, showed 50% increase in the frequency of blood glucose monitoring (Cafazzo, Casselman, Hamming, Katzman, & Palmert, 2012). A mobile phone depression prevention program (MEMO) was developed with the principles of CBT, and trialled with 855 adolescents from New Zealand (Whittaker, Merry, Stasiak, et al., 2012). Though the results of the intervention were not published, self-reports of participants suggest that that mobile phones are acceptable as a medium to deliver interventions such as CBT, and are perceived to have positive impact.

Almost 40% of young people report using the internet to seek information about mental health problems (J. Burns et al., 2010). The anonymity and constant availability of many online interventions can help to overcome some of the barriers to help-seeking (such as physical access and concern about confidentiality) in this group (Hosie et al., 2014). They also have high potential for cost-effectiveness (Andersson & Cuijpers, 2009; Andersson & Titov, 2014; Olff, 2015), particularly as user numbers of particular resources become large, and they have a shorter lead time to develop and take to scale, compared with training additional mental health clinicians.

Electronic delivery media should be further explored, with these media increasingly being a preferred by young people who wish to access health information and resources (Aspden & Katz, 2001; Santor, Poulin, LeBLANC, & Kusumakar, 2007). E-mental health therefore offers promising platforms to reach young people (Lal & Adair, 2014). Innovative models of health services using technologies to improve reach and access for young people are being proposed (J. Burns et al., 2015; Christensen & Hickie, 2010a), and preliminary results of these models are promising (Rickwood, Van Dyke, & Telford, 2015).

4.5 CHALLENGES

While the emerging literature highlights the potential of mHealth, there are several challenges that may impede its growth. Lack of sufficient empirical support and the limitations in the available few studies lower the acceptance of mobile technology in practice (Yuen, Goetter, Herbert, & Forman, 2012). Ethics is a growing concern among clinicians and other health service providers when employing technology in health care around privacy, data sharing and security (McMinn, Bearse, Heyne, Smithberger, & Erb, 2011). Digital technology usage by children and young people is found to improve their wellbeing, but some fear it may also have a counter-productive effect, like increasing loneliness, reducing academic performance and social interactions (Clifton, Goodall, Ban, & Birks, 2013). This calls for a

more rigorous research around the technological interventions. Authenticity and evaluation of apps for efficacy are growing challenges that need to be addressed before mHealth can reach its full potential.

4.6 SUMMARY

E-mental health is gaining more empirical support and could potentially help to address many of the challenges of youth mental health. Online interventions have substantial evidence for positive health outcomes with proven acceptability, adaptability and cost-effectiveness. Smartphones and the applications that run on them, "apps", are found to be viable medium for intervention delivery. In addition to wider reach, they provide additional advantages like anonymity, flexibility, personalisation and providing functionality with or without internet connection. Moreover there is an exponential growth in the number of app downloads and usage globally. These high levels of accessibility and acceptability of smartphones and apps, and their ever-growing technological advancements and communication features have the potential to reach more young people than conventional face-to-face services to help address the challenge of youth mental health.

It is imperative that health care apps contain high quality information and have positive effects for users (Lewis & Wyatt, 2014). E-mental health comprises a nascent but rapidly growing mHealth field, which while promising, needs rigorous research (Chib, 2013; Melnik, 2011; Nilsen et al., 2012; Whittaker, Merry, Dorey, & Maddison, 2012). The few trials on the efficacy of mobile health care apps show promising results for mobile apps as a delivery medium for health intervention. While there is currently more evidence for the efficacy of mindfulness training delivered online, there is growing evidence for the feasibility and acceptability of mobile delivered mindfulness training. The few trials on the effectiveness of mindfulness apps among young people have promising results, but suffer from numerous methodological limitations. Future research on the quality and efficacy of mindfulness apps in young people using more rigorous research method is urgently required.

Chapter 5: Overview of the research program

5.1 NEED FOR RESEARCH

The preceding chapters reviewed the current literature relating to youth mental health, mindfulness and the recent developments of e-mental health. The findings can be summarised as below:

- The high incidence and prevalence of mental illness among young people (16-25 years) is a growing concern globally
- The complex needs of this age group and the related challenges are unmet by the current predominantly illness-focused (mostly physical-illness) health care systems
- There is a lack of focus on health promotion, prevention and early intervention
- Mindfulness practice has substantial evidence of efficacy for improving wellbeing and reducing symptoms of stress, depression and anxiety among clinical and non-clinical population
- There is mounting evidence on efficacy, acceptability and feasibility of e-mental health services which include internet and mobile delivery of evidence-based interventions
- There is limited evidence of efficacy of mobile-delivered mindfulness training among young people

These finding drove the current research program which acknowledges and attempts to address the urgent need of the growing mental health concerns of young people. E-mental health, particularly, mHealth, while highly promising, especially for addressing these concerns, needs more evidence. This research program was conceived to contribute towards that need.

5.2 RESEARCH PROGRAM OVERVIEW

The current research program's primary objective was to identify high-quality mobile apps on mindfulness, and test the efficacy of one or more of these apps. This research program was executed in three stages and is presented in a thesis-by-publication format, with

each stage producing a scientific paper: (i) A systematic review and quality evaluation of existing mindfulness apps, (ii) a pilot study to compare the efficacy of a low- and high-quality mindfulness app and (iii) a randomised controlled trial to test the efficacy of a high-quality mindfulness app.

Table 1 Overview of the Research program

Study 1	**Objective:** Conduct a systematic review of mindfulness-based iPhone mobile apps and evaluate their quality **Design:** Contextual review, scientific evaluation of apps using MARS
	Paper: Review and evaluation of mindfulness-based iPhone apps *Citation:* Mani, M., Kavanagh, D. J., Hides, L., & Stoyanov, S. R. (2015). Review and evaluation of mindfulness-based iPhone apps. *JMIR mHealth and uHealth*, 3(3), e82.
Study 2	**Objective:** Compare the efficacy of a low- and high-quality mindfulness app identified in Study 1 to improve wellbeing of youth and explore young people's perceptions of the usability of apps as a platform for delivering mindfulness training. **Design:** Parallel randomised controlled trial
	Paper: Mobile Apps for Mindfulness – Results of a pilot study *Citation:* Mani, M., Kavanagh, D. J., & Hides, L. (2016). Mobile Apps for Mindfulness – Results of a pilot study. Submitted for publication.
Study 3	**Objective:** Examine the efficacy of a high-quality mindfulness app identified in Study 1, to improve wellbeing of youth. **Design:** Delayed controlled randomised trial

	Paper: Test of a mobile app for young people's mindfulness – A randomised controlled trial *Citation:* Mani, M., Kavanagh, D. J., Hides, L., & Cockshaw, W. D. (2016). Test of a mobile app for young people's mindfulness – A randomised controlled trial. Submitted for publication.

5.2.1 STUDY 1: SYSTEMATIC REVIEW OF IPHONE MINDFULNESS APPS

The proliferation of mobile apps in general and the growing number of health care apps pose many challenges. Health care apps are developed and released to market like any other app without any certification of authenticity or validity. There are no quality evaluations other than the user star-ratings and reviews. It is imperative that health apps contain high quality information and have positive effects for users (Lewis & Wyatt, 2014). Assessing quality of the app is a precursor to examining its efficacy as sustained use of mental health apps is essential for better health outcomes (M. Patel, Asch, & Volpp, 2015), especially for mindfulness practice (Bishop, 2002; Germer, 2005; Grossman et al., 2004; Kabat-Zinn, 2006). Presently, no standard methods for evaluating mobile apps exist. The Mobile App Rating Scale (MARS) (Stoyanov et al.) is a recently developed innovative tool to evaluate mobile apps beyond user ratings. Study 1 aimed to review and evaluate existing mindfulness apps using the MARS and identify a high-quality app for further examination.

5.2.2 STUDY 2: COMPARING EFFICACY OF A LOW- AND HIGH-QUALITY MINDFULNESS APP - A PILOT STUDY

Study 2 was conceived as a pilot to assess the challenges and feasibility of conducting a full trial. The main objective of this study was to compare the efficacy of a low- and high-quality mindfulness training app identified in Study 1 to assess if the outcomes differed by quality of the apps. It also aimed to explore young people's perceptions of the usability of apps as a platform for delivering mindfulness training and motivating its practice. Twenty-seven young people (16-25 years) were randomly allocated to a low- (Cleveland Stress Free) or high-rating (Smiling Mind) mindfulness training app. Participants were asked to use the respective app for 4 weeks. Measures of mental wellbeing (MHC-SF), psychological distress

(K10) and mindfulness (CAMSR) were completed at baseline and 4 weeks later at post-intervention. A semi-structured qualitative interview was conducted with eight participants.

5.2.3 STUDY 3: TEST OF A MOBILE APP FOR YOUNG PEOPLE'S MINDFULNESS – A RANDOMISED CONTROLLED TRIAL

Study 3 examined the efficacy of Smiling Mind app for improving the wellbeing of young people and the effects of reminders on the efficacy, in a randomised controlled trial. Young people (16-25 years) with at least mild level of distress were recruited for the study (n=185). Participants were required to have access to an iPhone or an Android phone and have no prior mindfulness practice experience. They were randomly allocated to one of three groups: Immediate access, immediate access with Reminders or a 6-week Delayed access group. Participants in the Reminders group received weekly reminder calls for the first 6 weeks. Mental wellbeing (MHC-SF), psychological distress (K10), mindfulness (CAMSR) and happiness (Oxford Happiness Questionnaire – Short Form; OHQ-SF) were measured at baseline, 6, 12 and 18 weeks.

Chapter 6: Review and evaluation of mindfulness iPhone apps

This manuscript presents the first study of the research program and its outcomes. The main objective of this study was to review and evaluate existing mindfulness apps and identify a high-quality app for further examination. As highlighted earlier in this thesis, the number of mobile apps available in the market is growing at an exponential rate and worldwide app downloads are expected to reach a staggering 268.69 billion in 2017 (Figure 5)(Statista, 2016). The potential use of mobile apps in intervention delivery is gaining

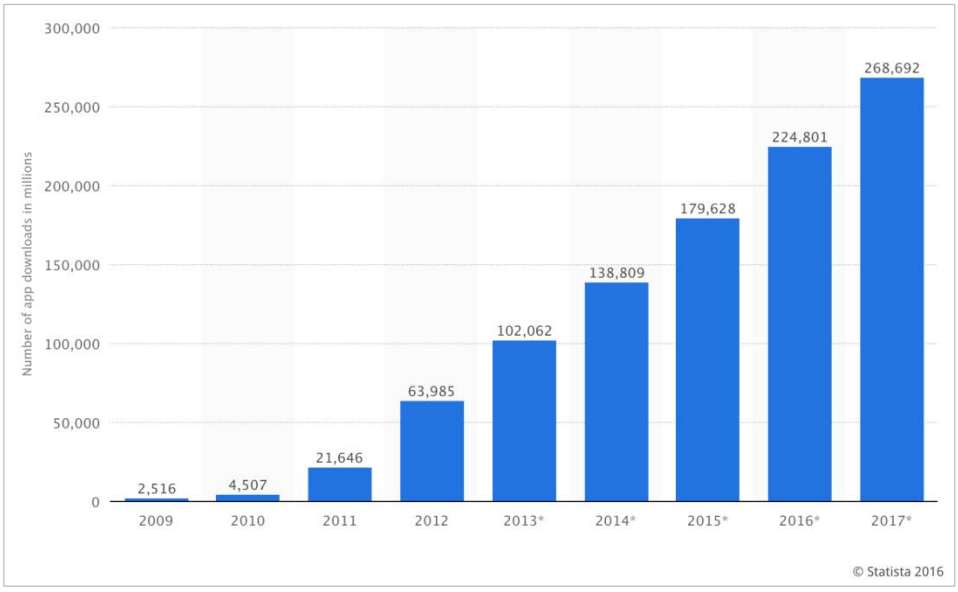

Figure 5 Number of App downloads worldwide from 2009 to 2017

attention along with its limitations and challenges (Chan, Torous, Hinton, & Yellowlees, 2015, 2016). While many mobile apps for mental health care are already available in the market, little information is available on the quality or efficacy of these apps, beyond user reviews and star ratings (Mohr, Cheung, Schueller, Hendricks Brown, & Duan, 2013). In particular, while there is growing evidence for the positive impacts of face-to-face mindfulness-based training programs, it is unclear if mindfulness-based apps can provide the same effects. The first study in this research program aimed to review the existing mindfulness apps and evaluate the quality of the apps using a recently developed expert rating scale. The review focused on iOS apps as mindfulness apps were predominant in iOS than Android when the study was conceived. This was acknowledged as a limitation of the study.

This paper has been published in the peer reviewed journal, Journal of Medical and Internet Research (JMIR) mHealth and uHealth.

Citation:

Mani, M., Kavanagh, D. J., Hides, L., & Stoyanov, S. R. (2015). Review and evaluation of mindfulness-based iPhone apps. *JMIR mHealth and uHealth*, 3(3), e82.

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Statement of Contribution of Co-Authors for Thesis by Published Paper

The following is the suggested format for the required declaration provided at the start of any thesis chapter which includes a co-authored publication.

The authors listed below have certified* that:

1. they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
2. they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
3. there are no other authors of the publication according to these criteria;
4. potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit, and
5. they agree to the use of the publication in the student's thesis and its publication on the Australasian Research Online database consistent with any limitations set by publisher requirements.

In the case of this chapter:

Review and evaluation of mindfulness-based iPhone apps

Contributor	Statement of contribution*
Madhavan Mani [signature] 25-Jul-2016	wrote the manuscript, experimental design, data collection and analysis
Prof David Kavanagh	aided experimental design, data analysis, and manuscript editing
Prof Leanne Hides	aided experimental design, data analysis, and manuscript editing
Stoyan Stoyanov	data analysis, and manuscript editing

Principal Supervisor Confirmation

I have sighted email or other correspondence from all Co-authors confirming their certifying authorship.

DAVID KAVANAGH — Name

[signature] — Signature

25/7/16 — Date

Abstract

Background: There is growing evidence for the positive impact of mindfulness on wellbeing. Mindfulness-based mobile apps may have potential as an alternative delivery medium for training. While there are hundreds of such apps, little information is available on their quality.

Objective: This study aimed to conduct a systematic review of mindfulness-based iPhone mobile apps and evaluate their quality using a recently-developed expert rating scale, the Mobile Application Rating Scale (MARS). Features of selected high-quality mindfulness apps were also described.

Methods: Apple App Store was searched for "mindfulness" iPhone apps through iTunes and Google app search. Mindfulness apps that provided mindfulness training and education were included. Those containing only reminders, timers or guided meditation tracks were excluded. An expert rater reviewed and rated app quality on the MARS engagement, functionality, visual aesthetics, information quality and subjective quality subscales. A second rater provided MARS ratings on 30% of the apps for inter-rater reliability purposes.

Results: The search for "mindfulness" identified 700 apps. However, 94 were duplicates, 6 were not accessible and 40 were not in English. Of the remaining 560, 23 apps that met inclusion criteria were reviewed and rated. The median MARS score was 3.2 (out of 5.0), which exceeded the minimum for acceptability on the MARS (3.0). The Headspace app scored the highest MARS average (4.0), followed by Smiling Mind (3.7), iMindfulness (3.5) and Mindfulness Daily (3.5). MARS ratings by the two raters had a high level of inter-rater reliability.

Conclusions: Though many apps claim to be mindfulness related, most were guided meditation apps, timers or reminders. Very few had high ratings on the MARS subscales of Visual Aesthetics, Engagement, Functionality or Information Quality. Little evidence is available on the efficacy of the apps in developing mindfulness.

Keywords: Mindfulness, mindfulness-based mobile apps, mHealth, health promotion

6.1 INTRODUCTION

Mindfulness has grown in popularity in the last two decades, and there is growing evidence for its positive impact on wellbeing (Keng et al., 2011; M. Slade, 2010). Many different perspectives of mindfulness have evolved over this period. An influential definition by Jon Kabat-Zinn is that mindfulness is "paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experience moment by moment" (Kabat-Zinn, 2006, p. 145). Mindfulness is seen as a skill that can be developed through practice. The benefits of present-centred attention and acceptance of experience that can be achieved through mindfulness include enhanced awareness, greater self-regulation, greater openness and acceptance to experiences and the development of new perspectives on the context and content of information (Langer, 1992). This contrasts to mindlessness, where an individual's attention is focused on past experiences and concerns about the future, rather than the present moment (Langer & Moldoveanu, 2002).

Consistent with these perspectives, mindfulness has been found to have salutary psychological, somatic, behavioural, and interpersonal effects (Brown et al., 2007), developing personal qualities such as a non-judgmental, non-striving perspective, acceptance, patience, trust, openness, letting go, gentleness, generosity, empathy, gratitude and loving-kindness: each of which are relevant to the personal recovery of people with mental disorders, as well as to positive wellbeing in general (M. Slade, 2010). Consistent with this view, mindfulness has been found both to reduce psychological distress and optimize psychological functioning in young people (Coffey et al., 2010). There is growing evidence for the efficacy of mindfulness-based programs in promoting wellbeing (Irving, Dobkin, & Park, 2009), reducing depression (Khoury et al., 2013b) and preventing relapse in depression (Chiesa & Serretti, 2011).

While mindfulness can be an effective intervention to reduce symptoms of mental illness and promote health and wellbeing, finding an effective delivery medium to a wider audience remains a challenge.

6.1.1 APPS FOR MENTAL HEALTH (MHEALTH)

The global prevalence and burden of mental disorders is substantial, and delivering mental health services effectively to millions in need remains a challenge (Kazdin & Rabbitt, 2013). While internet interventions are gaining empirical support (Geraghty, Torres, Leykin, Pérez-Stable, & Muñoz, 2013), development of mobile interventions is in its infancy (Free et

al., 2013). Mobile health (mHealth) is an emerging field, which uses wireless technologies like mobile phones and other accessories in health practice. With the advent of smartphone applications (apps), technology has created an impact which was never seen before. Smartphones are highly flexible in usage and can keep the user connected to internet at all times. Apps provide computing facility comparable to a desktop computer with the advantage of mobility.

There is a strong growth of smartphone usage worldwide (Meeker, 2016), and mobile usage now constitutes 25% of total web usage. A recent Australian Mobile Phone Lifestyle Index report (Mackay, 2014) reported that 88% of its survey respondents use websites or applications on their mobile phone, and predicted that 92% of respondents would own a smartphone by October 2015, highlighting the continued rapid growth of smartphone uptake. Global mobile app downloads is expected to reach 269 billion in 2017 ("Number of mobile app downloads worldwide from 2009 to 2017 (in millions),"). Usage by young people is particularly high: The Australian Communications and Media Authority reported that at May 2013, 89% of people aged 18–24 years had a smartphone and 83% of this age group downloaded an app in the previous 6 months (Editor, 2013). E-technologies are also well accepted by young people as sources of health information: In a recent survey, 39% of young people reported using the internet to seek information about a mental health problem (J. Burns et al., 2010). An implication of this wide acceptance of e-technologies is that they may offer a medium to improve the wellbeing of young people by supporting the development of mindfulness (J. Burns et al., 2010; Christensen & Hickie, 2010b).

The Apple App store now has a staggering 1.3 million apps (Statista, 2014), including many that are health-related. However, little information is available on the quality or efficacy of these apps, beyond user reviews and star ratings (Mohr et al., 2013). It is imperative that health apps contain high quality information and have positive effects for users(Lewis & Wyatt, 2014).

In particular, while there is growing evidence for the positive impacts of face-to-face mindfulness-based training programs, it is unclear if mindfulness-based apps can provide the same effects. A search for studies in various databases (ERIC, MEDLINE, PsycINFO, Web of Science, ProQuest) only identified one randomised controlled trial (Howells et al., 2014) examining the efficacy of a mindfulness app, despite their growing number.

The present study conducted a systematic review of mindfulness-based iPhone mobile apps. It also evaluated the quality of mindfulness apps using an expert rating scale and described features of the highest scoring apps.

6.2 METHODS

6.2.1 SYSTEMATIC SEARCH

A systematic search of mindfulness-based iPhone mobile apps accessible from Australia was conducted in June 2014. The search was conducted using the Google app search function as well as the search feature in the iTunes app store. The Google app search comprised the search terms: mindfulness, vipassana, mindful, meditation, present moment and excluded the terms: hypnosis, hypnotize, weight, magazine, mindmap, mind map, mind-map, binaural. In iTunes, the term 'mindfulness' was used to search, as the search feature was more limited.

Preliminary screening removed irrelevant apps (music/relaxation, happiness, inspirational cards, games, clocks, etc.), apps in other languages than English, and those that were not readily accessible. Mindfulness apps that were secular, explicated mindfulness practice (mindfulness education), and also had guided mindfulness training were included. Apps that only gave reminders, timers or guided meditation tracks were excluded, as were apps that cost more than $10 (on the grounds that the latter apps were unlikely to be purchased by large numbers of users). The apps were rated and reviewed in iOS7 with an iPhone 5s.

6.2.2 MEASURES/RATING TOOL

The Mobile Application Rating Scale (MARS) (Stoyanov et al.) was used to rate app quality. The MARS contains three sections: classification, app quality, and satisfaction. The classification section is only for descriptive purposes. The 19-item app quality section rates apps on four quality subscales: Engagement, Functionality, Aesthetics, and Information Quality. The subjective quality section contains 4 items evaluating the user's overall satisfaction. The MARS has demonstrated excellent internal consistency ($\alpha = 0.92$) and inter-rater reliability (ICC = 0.85) (Stoyanov et al.). A second rater (last author) reviewed and rated 30% of the apps on the MARS for inter-rater reliability purposes.

6.3 RESULTS

6.3.1 SYSTEMATIC SEARCH

The Google app search and iTunes searches identified 323 and 377 apps respectively (Figure 6). Excluding duplicates, there were 606 apps. However, 10 were not accessible, 40 were in other languages than English, and 296 were not relevant (music/relaxation, happiness, inspirational cards, games, clocks, etc.). Of the remaining 260, 23 met inclusion criteria.

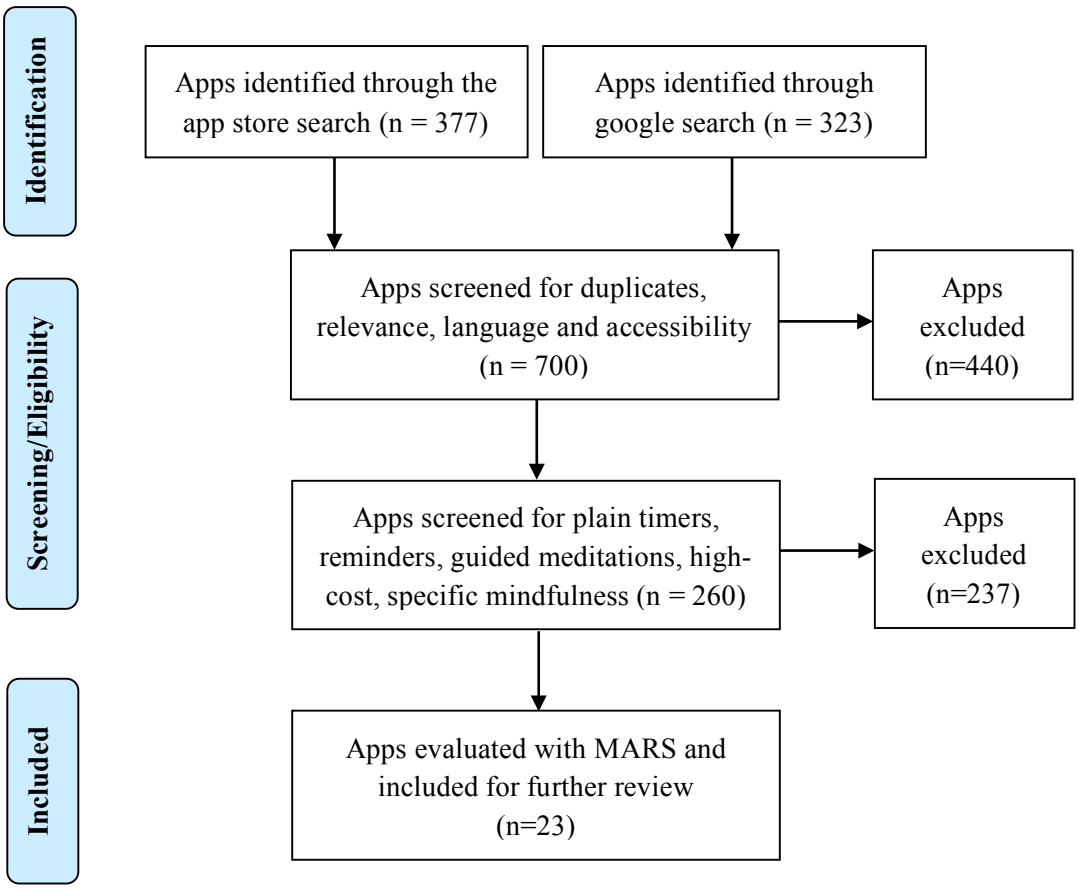

Figure 6 Systematic search for mindfulness apps in Apple App Store

Excluded apps comprised those containing timers or reminders (74), guided meditation tracks for common practice or special occasions (129; religious practice/pregnancy/eating/exercise), or information (37; eBooks/audiobooks/guidelines, without any tools to practice) only. Nine of the included apps were free and the rest were priced from $2.49 to $5.99.

6.3.2 MOBILE APPLICATION RATING SCALE - APP QUALITY

Table 2 shows the subscale and overall scores of apps rated with MARS. It was not possible to rate Item 19 of the MARS which provides a measure of the evidence base for the

apps, as a Google Scholar search only identified one efficacy study on the included apps (Howells et al., 2014). Seven apps (30%) were evaluated by two expert raters, and excellent level of inter-rater reliability was found (two-way mixed ICC = 0.84; 95% CI 0.79-0.87).

The Headspace app had the highest average MARS total (4.0) and subscale scores. Next highest were Smiling Mind (3.7), iMindfulness (3.5) and Mindfulness Daily (3.5). Mindfulness Trainer (2.6) scored lowest. The median MARS score of the apps was 3.2, and all but three scored at least at the minimum acceptability level of 3.0. Satisfaction (the only totally subjective subscale) was not included in the overall score.

6.3.3 FEATURES OF HIGH QUALITY MINDFULNESS APPS

Features of the reviewed apps are summarised in Tables 2 and 3. All contained guided meditations and mindfulness education. They also had at least 2 of the following 9 most common types of guided meditations (Kabat-Zinn, 2013):

- Breathing – awareness of the in and out breathes, with deep breathing
- Body scan – awareness of the body focusing on each of the body parts, usually starting from the toes and progressively moving towards the head
- Sitting meditation – breathing meditation in a sitting posture, with awareness of the body
- Walking meditation – practicing mindful walking, raising awareness of each movement as we walk slowly
- Loving kindness meditation – a meditation practice to accept, love and show kindness to oneself and others
- Thoughts and emotions – acknowledging thoughts and emotions non-judgmentally, as they arise and are let go
- Mountain meditation – a guided imagery practice, imagining oneself as a mountain and feeling stronger
- Lake meditation – a guided imagery practice, imagining oneself as a lake, experiencing stillness and peace

Three-minute breathing space – a 3-minute guided meditation, with becoming aware in the first minute, gathering and focusing attention in the second minute and expanding the attention in the third minute.

Almost all apps provided mindful breathing and body-scan exercises. Only one contained all 9 types of guided meditations (Mindfulness Trainer) and few contained loving kindness, lake and mountain meditations. Buddhify 2 differed from the rest by providing guided meditations to practice in different situations, viz. exercising, working online, sleeping, work break, etc. The quality of recording, voice used and the pace of the delivery of guided meditations varied from app to app.

Table 2 MARS Rating of Apps (Study 1)

	App[a]	Engagement	Functionality	Aesthetics	Information[b]	Satisfaction	Overall
1	Headspace[c]	**3.8**	**4.8**	**4.7**	**4.0**	**4.0**	**4.0**
2	Smiling Mind[c]	**3.4**	**4.5**	**4.3**	**3.8**	**4.0**	**3.7**
3	iMindfulness[c]	3.0	**4.8**	3.7	**3.7**	2.5	**3.5**
4	Mindfulness Daily	3.2	**4.0**	**4.0**	**3.7**	**3.3**	**3.5**
5	Buddhify 2	**3.6**	3.8	3.7	3.5	**3.8**	3.4
6	Complete Mindfulness[c]	3.0	**4.0**	**4.0**	**3.7**	2.8	3.4
7	Mindfulise	**3.6**	3.5	**4.0**	3.3	2.5	3.4
8	ACT Coach	3.0	**4.0**	3.0	**3.8**	3.5	3.3
9	Rhythm Free	3.4	3.5	**4.0**	3.2	3.0	3.3
10	Simply8	2.8	3.8	**4.0**	3.5	2.8	3.3
11	Stop, Breathe & Think	3.2	**4.0**	3.3	3.3	3.0	3.3
12	Mindfully Me	3.0	**4.0**	3.3	3.3	2.5	3.2
13	The Meditation App with Michael Stone	3.0	**4.0**	3.0	3.5	2.5	3.2
14	Meditation without borders[c]	2.6	**4.0**	3.3	3.5	2.8	3.2
15	Mindfulness Coach	2.8	3.8	3.0	**3.7**	2.8	3.2
16	The Mindfulness App[a]	3.0	3.8	3.0	3.5	2.5	3.2
17	Take a Chill[c]	3.2	3.5	2.7	3.5	2.5	3.1
18	iMindfulness - On The Go	3.0	3.8	3.0	3.2	2.5	3.1
19	Personal Coach - Mindfulness	3.0	**4.0**	2.7	3.2	2.5	3.1
20	The Breathing Anchor - Andries J Kroese	2.8	3.8	2.7	3.3	2.5	3.0
21	Mindfulness by Potential Project	2.8	3.5	2.7	3.0	2.0	2.8
22	Cleveland Clinic - Stress Free Now	2.4	3.8	2.7	3.0	2.5	2.8
23	Mindfulness Trainer	2.2	3.3	2.3	3.0	1.8	2.6

[a] The rated versions of the apps may not be available in the App Store when the study is published, as they may be replaced by newer versions. [b] The information quality score excluded item 19 of the MARS. [c] Rated by two raters for inter-rater reliability purposes.

Table 3 Summary of mindfulness-based apps features (Study 1)

#	App	Timer	Reminders	Mood assessments	Tracking	Program-based Practice	App community	Social Media	In-app Purchase	Cost
1	Headspace	✓	✓		✓	✓	✓	✓	✓	Free
2	Smiling Mind	✓	✓	✓	✓	✓		✓		Free
3	iMindfulness	✓	✓		✓				✓	$2.49
4	Mindfulness Daily	✓	✓	✓	✓	✓		✓	✓	Free
5	Buddhify 2	✓			✓				✓	$3.79
6	Complete Mindfulness									$2.49
7	Mindfulise	✓			✓					$3.79
8	ACT Coach				✓					Free
9	Rhythm Free	✓	✓		✓			✓	✓	Free
10	Simply8	✓	✓			✓		✓		$3.79
11	Stop, Breathe & Think			✓	✓			✓		Free
12	Mindfully Me	✓	✓		✓			✓		Free
13	The Meditation App with Michael Stone	✓	✓		✓			✓		$3.79
14	Meditation without borders					✓		✓		$5.99
15	Mindfulness Coach	✓	✓		✓					Free
16	The Mindfulness App	✓	✓		✓			✓	✓	$2.49
17	Take a Chill[f]	✓	✓		✓			✓	✓	$2.49
18	iMindfulness On The Go	✓	✓		✓				✓	$2.49
19	Personal Coach - Mindfulness	✓	✓							$2.49
20	The Breathing Anchor - Andries J Kroese	✓	✓		✓					$2.49
21	Mindfulness by Potential Project	✓	✓		✓					$2.49
22	Cleveland Clinic - Stress Free Now									Free
23	Mindfulness Trainer									$3.79

The majority of apps contained timers and provided reminders. Seven did not have a timer (ACT Coach, Complete Mindfulness, 'Stop, Breathe & Think', Meditation without borders, MindKind Now, Cleveland Clinic - Stress Free Now, Mindfulness Trainer) and nine did not have reminders (ACT Coach, Buddhify 2, 'Cleveland Clinic - Stress Free Now', Complete Mindfulness, Meditation without borders, Mindfulise, Mindfulness Trainer, MindKind Now, Stop, Breathe & Think).

Five apps provided progressive/program-based mindfulness training (Headspace, Smiling Mind, Mindfulness Daily, Simply8 and Meditation Without Borders). Headspace provided free access to a 10-day program, 'Take 10', which had ten guided meditation sessions of approximately 10 minutes each. Completing a session unlocked the next meditation track. Smiling Mind had a 10-week program for different age groups. The introductory session in the start of each week explored breath, sounds, tastes etc. The user was advised to practice mindfulness and relevant take-home activity with the assistance of the app. Simply8 was a 3-week program with 8 minutes of guided meditation everyday under the themes of calm, clear, and aware (focusing on one theme each week). Mindfulness Daily provided short mindfulness exercises for 21 days. The user can also access guided meditations like body scan, kindness and awareness anytime. Meditation without borders was a 4-week program advising the users to practice guided meditations for at least 20 minutes per day.

While most apps provided exclusive texts and video explaining the concepts of mindfulness some apps relied on guided meditation tracks to educate the user on mindfulness. Take a chill gave references to relevant websites and did not provide much mindfulness education within the app. Few apps (e.g. ACT Coach, Complete Mindfulness) provided comprehensive text-based education. Headspace uses video infographics to explain the concepts. Two of the apps (Mindfulness by potential project and iMindfulness) mentioned the seven attitudes for mindfulness training, otherwise known as the essential pillars of MBSR practice (Kabat-Zinn, 2013).

Twelve apps provided option to share experience in social networks like Facebook and Twitter (Headspace, Meditacious, Meditation without borders, Mindfully Me, Mindfulness Daily, Rhythm Free, Simply8, Smiling Mind, 'Stop, Breathe & Think', Take a Chill, The Meditation App with Michael Stone, The Mindfulness App). Headspace and Meditacious also had an app community. Eight apps provided in-app purchase that included additional guided

meditation tracks (Take a Chill, iMindfulness-On-The-Go, Headspace, Mindfulness Daily, The Mindfulness App, iMindfulness, Buddhify 2) and reminders (Rhythm Free).

6.4 DISCUSSION

6.4.1 PRINCIPAL RESULTS

Though the search for 'mindfulness' apps identified 606 apps, only 23 provided mindfulness training and education. Timers, reminders, meditation, relaxation or reference apps can assist in mindfulness practice, but categorising them as mindfulness apps is inappropriate (Gunaratana, 2011).

Mindfulness is much more than meditation, a breathing exercise or a relaxation technique. Meditation is a practice that aids development of mindfulness (Olendzki, 2009; B. L. Thompson & Waltz, 2007), breathing is used as an exercise in the practice of mindfulness and relaxation can be an outcome. Contemplative practices (breathing, sitting, walking meditations), understanding emergent bodily and mental experiences, and withdrawing from habitual experiential avoidance form part of mindfulness training in mindfulness-based interventions like MBSR and MBCT (Monteiro, Musten, & Compson, 2014). A mindfulness app should clearly explain the philosophy and practice of mindfulness and address common misconceptions. An app without mindfulness education may be beneficial if this information has been provided as part of face-to-face mindfulness training. However a stand-alone mindfulness app should educate the user on mindfulness. All of the apps included in the review explain the concept of mindfulness at varying levels. Some (e.g. Headspace, smiling mind) employed interesting visual modes of explanation.

Mindfulness is a habit and a mind-training skill that requires regular practice and sustained effort to be effective (Bishop, 2002; Germer, 2005; Grossman et al., 2004; Kabat-Zinn, 2006). This is a challenge for both face-to-face and app-based mindfulness training. Mindfulness apps provide 24/7 access to mindfulness-based practice. Interactive mobile applications and aesthetically pleasing and well-designed apps are likely to be more effective in engaging the user in regular mindfulness practice (Cyr, Head, & Ivanov, 2006; Maghnati & Ling, 2013). Headspace, Mindfulise, Buddhify 2 and Smiling Mind scored high on the MARS engagement subscale. These apps had high quality graphics, simple and easy to use interface, and soothing voice for the guided meditation tracks. Headspace used short video infographics that complemented the guided meditation tracks. Unlike most apps that used a linear menu style, Buddhify 2 used an interesting collapsible circular menu to choose the meditation

tracks. The reviewed apps generally scored low (< 3.0) on the MARS engagement subscale, highlighting the need to focus on engagement and motivation during the design process.

Participation in an app community can help motivate users to engage in healthy activities (Ba & Wang, 2013). A supportive app community can help users share and discuss their mindfulness experiences and the challenges of regular practice. This could potentially complement or substitute for the support provided in face-to-face mindfulness training. While nearly 50% of the reviewed apps provided social network sharing, only Headspace and Meditacious incorporated app community support. Research is required to determine the impact of sharing in social media and participating in a supportive app-community on the frequency of mindfulness-based practice.

Assessing the quality of an app, especially a health intervention app, is an essential step before evaluating its efficacy(Boudreaux et al., 2014). The 23 mindfulness apps reviewed in this study had a median objective quality MARS score of 3.2. This suggests the apps had an overall acceptable level of quality. However, the low median engagement and moderate median aesthetics and information subscales scores highlight potential target areas for improving the quality of mindfulness apps.

6.4.2 STRENGTHS AND LIMITATIONS

This study is one of the first to review mindfulness-based iPhone apps and evaluate their quality using a new multidimensional expert rating scale. The MARS provides a reliable measure of app quality on four objective subscales (engagement, functionality, visual aesthetics, information quality) and one subjective scale. Only the objective quality scales are included in the total app quality score. Expert ratings on 30% of the reviewed apps had a high level inter-rater reliability in the current study.

The current review was limited to iPhone iOS apps, indicating future research is required to review and rate the quality of Android apps. Future research is also required to assess the quality of individual guided-meditation tracks in the reviewed apps.

6.4.3 FUTURE RESEARCH

Mobile health or mHealth is fast becoming an essential component of global health care(Farrington, Aristidou, & Ruggeri, 2014). The majority of mHealth apps developed to date have focused on physical health and lifestyle domains rather than mental health (Free et al., 2013; Harrison et al., 2011). While an increasing number of mindfulness apps are being

developed, the current evidence base is limited to one trial examining the efficacy of Headspace app (Howells et al., 2014). Future research is needed to determine and compare the efficacy of mindfulness apps in randomised controlled trials.

6.5 CONCLUSIONS

Only 4% of the 700 apps identified in our search provided mindfulness training and education. Though many apps claim to be mindfulness apps, most of them were not. While the reviewed apps scored a MARS median score at acceptable level, very few scored high, indicating that the quality of the apps can be improved. The lack of evidence for the effectiveness of mindfulness apps needs to be addressed.

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Associate Professor Leanne Hides is supported by an Australian Research Council Future Fellowship.

Conflicts of Interest

None declared.

6.6 COMMENTS

The versions of most the apps reviewed and evaluated in this study were not available in the app store when the paper was published. The apps were either upgraded to higher versions with additional features or with bug fixes. This demonstrates the rapid pace of development in technology and the slow pace of traditional research methodologies. While typically mobile apps can be developed in few weeks, research, especially RCTs, take years (Anguera, Jordan, Castaneda, Gazzaley, & Areán, 2016). This is a challenge in mHealth research.

Only five of the 23 apps that were reviewed in this study provided a program-based approach for mindfulness training. Most MBIs that gained empirical support deliver mindfulness training in a structured approach, predominantly based on the 8-weeks structure of MBSR. It is possible that mindfulness apps that deliver mindfulness training in a structured program-based approach may have an advantage. However, the efficacy of the app may depend on the context and purpose of its use; the app could be used as an adjunct to a therapy or a standalone training app with or without facilitator.

Chapter 7: Mobile Apps for Mindfulness – Results of a pilot study

This manuscript presents the second study of the research program and its outcomes. As highlighted earlier, despite the growing number of mindfulness apps, there is little evidence on their efficacy. Study 1 found that the apps varied in quality and very few high-quality mindfulness apps exist.

Study 2 aimed to test the efficacy of a low- and high-quality app and also find if the effects differed by the apps' quality. A high-quality app (Smiling Mind) and a low-quality app (Cleveland Stress Free) were compared for efficacy to improve wellbeing of youth. The study also explored young people's perceptions of the usability of apps as a platform for delivering mindfulness training.

This paper has been submitted to the peer-reviewed journal, Behaviour Change and is under review.

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In the case of this chapter:

Mobile Apps for Mindfulness – Results of a pilot study

Contributor	Statement of contribution*
Madhavan Mani [signature] 25-Jul-2016	wrote the manuscript, experimental design, data collection and analysis
Prof David Kavanagh	aided experimental design, data analysis, and manuscript editing
Prof Leanne Hides	aided experimental design, data analysis, and manuscript editing

Principal Supervisor Confirmation

I have sighted email or other correspondence from all Co-authors confirming their certifying authorship.

DAVID KAVANAGH — Name

[signature] — Signature

25/7/16 — Date

Abstract

Background: Mobile applications (apps) have the potential to provide an effective platform for delivering mindfulness training to large numbers of users. Mobile apps can facilitate regular practice, which is essential for effective mindfulness training. However, there is little evidence for the efficacy of mindfulness training apps.

Objective: This pragmatic pilot study compared the efficacy of a low- and high-quality mindfulness training apps identified using the Mobile App Rating Scale (MARS). Young people's perceptions of the usability of apps as a platform for delivering mindfulness training and motivating its practice were also explored.

Methods: Twenty-seven young people (16-25 years) were randomly allocated to a low- (Cleveland Stress Free) or high-rating (Smiling Mind) mindfulness training app. Participants were asked to use the respective app for 4 weeks. Measures of mental wellbeing (Mental Health Continuum-Short form), psychological distress (Kessler 10) and cognitive and affective mindfulness skills (Cognitive and Affective Mindfulness Scale – Revised) were completed at Baseline and post-intervention. A semi-structured qualitative interview was conducted with eight participants.

Results: Only 10 of the 27 participants (37%) who were randomised to a mindfulness app completed the post-intervention survey. A significant improvement in mental wellbeing was found among completers in both groups. However, no between-groups differences in wellbeing outcomes were found by app type. No changes in psychological distress or mindfulness skills were found. The qualitative analysis indicated participants were interested in learning more about mindfulness. Awareness about mindfulness practice and its benefits were highly regarded as potential motivating factors.

Conclusions: The apps were well received as a medium for mindfulness training among completers. Wellbeing improved over the course of the study, regardless of whether participants used a lower or higher quality app. Mindfulness education and development of motivation to practice may be key factors in effective mindfulness app design. No conclusions about the efficacy of either mindfulness app can be made, due to high attrition and lack of a control group.

Keywords: Mindfulness, mobile apps, mHealth, health promotion, young people

7.1 INTRODUCTION

Mindfulness is increasingly gaining empirical support for its positive impact on wellbeing (Creswell, 2016; Keng et al., 2011; Neff & Germer, 2013; M. Slade, 2010). Mindfulness-based interventions—and particularly mindfulness-based stress reduction (MBSR) and mindfulness-based cognitive therapy (MBCT)—are found to improve quality of life (Godfrin & van Heeringen, 2010; Josefsson et al., 2013), reduce symptoms of depression in both clinical and non-clinical populations (Gu et al., 2015), and reduce distress and optimize psychological functioning in young people (Coffey et al., 2010).

Regular mindfulness practice improves perceived quality of life and assists with the generalization of formal mindfulness practice to everyday life (Machado & Costa, 2015). While continued practice is challenging, especially for beginners (Gunaratana, 2011), it is essential for maintaining treatment gains. For example, informal mindfulness practice at post treatment was significantly related to continued beneficial outcomes for quality of life and worry among individuals with Generalized Anxiety Disorder (GAD) (L. P. Morgan, Graham, Hayes-Skelton, Orsillo, & Roemer, 2014).

Face-to-face mindfulness training might not be feasible for all, and web and mobile-based mindfulness programs provide an accessible, flexible and potentially cost-effective alternative delivery method (Plaza, Demarzo, Herrera-Mercadal, & García-Campayo, 2013). Smartphones and apps, with a strong growth of usage worldwide (Meeker, 2016), provide wider reach and variety of choice. While there is growing evidence for the feasibility and effectiveness of web-based online mindfulness training (Cavanagh et al., 2013; Kemper & Yun, 2015; Krusche et al., 2013; Mak et al., 2015; Morledge et al., 2013; Spijkerman et al., 2016) only limited research on mindfulness apps has been conducted to date.

While over 600 mindfulness apps are currently available in app stores (Mani, Kavanagh, Hides, & Stoyanov, 2015), it is difficult for consumers to choose high quality apps, as little information on their quality or efficacy is available, beyond user reviews and star ratings (Mohr et al., 2013). This is concerning, as the utility of health intervention apps relies on the quality of the information provided and the extent they demonstrate positive effects for users (Lewis & Wyatt, 2014).

We recently conducted an expert quality review of 23 mindfulness apps for iPhones. App quality was examined using the Mobile App Rating Scale (MARS) (Mani et al., 2015; Stoyanov et al., 2015), which provides ratings of app engagement, functionality, aesthetics,

information and satisfaction. The current pilot study compared the efficacy of a low- and high-quality mindfulness app that were identified in the previous study (Mani et al., 2015), to determine if the efficacy of mindfulness apps varies by quality. A qualitative study was also conducted to explore young people's perceptions of the usability of apps as a platform for delivering mindfulness training and their motivation to engage in mindfulness practice.

7.2 METHODS

7.2.1 PARTICIPANTS

The study was advertised through university and research participant mailing lists and the social media links of the Young and Well Cooperative Research Centre (Young and Well CRC). Participants were required to be 16-25 years of age and have access to an iPhone.

7.2.2 MEASURES

7.2.2.1 Cognitive and affective mindfulness scale-revised (cams-r)

The 12-item CAMS-R (Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2007) measures the four domains of mindfulness (attention, present-focus, awareness, acceptance). Items are rated on a Likert scale from 1 (rarely/not at all) to 4 (almost always). Higher scores reflect greater mindfulness. The measure demonstrated acceptable internal consistency and convergent validity with similar measures when administered to university students (Feldman et al., 2007).

7.2.2.2 Kessler-10 (K10)

The K10 (R. C. Kessler, Barker, Colpe, & et al., 2003) is a well-validated 10-item measure of the frequency of anxiety and depression symptoms experienced in the previous 4 weeks. Items are rated on a 5-point Likert scale and are summed to give total scores representing low (10-15), medium (16-29) or high (30-50) risk of depressive symptoms. The scale was found to be highly reliable ($\alpha = .93$) for general population (R. C. Kessler et al., 2003).

7.2.2.3 Mental Health Continuum–Short Form (MHC–SF)

The 14-item MHC–SF (Lamers, Westerhof, Bohlmeijer, ten Klooster, & Keyes, 2011) measures the degree of (i) Emotional wellbeing (items 1–3) defined in terms of positive affect (PA)/satisfaction with life; (ii) Social Wellbeing (items 4–8: social acceptance, social actualization, social contribution, social coherence and social integration); and (iii)

Psychological Wellbeing (items 9–14: autonomy, environmental mastery, personal growth, positive relations with others, purpose in life and self-acceptance). The MHC-SF was found to have high levels of reliability ($\alpha > .80$) among an adolescent sample (Guo et al., 2015).

7.2.3 INTERVIEWS

A semi-structured interview was conducted with participants at the end of the study. Eight of the ten participants who completed the post-survey were interviewed. It was not possible to contact one participant and another declined for personal reasons. The interviews lasted up to 10 minutes. The interview aimed to explore conceptualization of mindfulness (e.g. "what is mindfulness in your opinion?"), motivation to practice (e.g. "what motivates young people to practice mindfulness?") and perceived helpful features in mindfulness apps (e.g. "what features do you expect in a mindfulness app?").

7.2.4 PROCEDURE

Eligible participants were requested through email to complete a web-based survey containing the MHC-SF, K10 and CAMS-R. Respondents who completed the baseline survey were randomly allocated to either Cleveland app (n=14) or Smiling Mind app (n=13). An in-house research management tool (Goji) was used for random allocation. Participants were told their allocation and given the link to their app by email. They were asked to download the app and use it for 4 weeks. They were not given any advice on the recommended frequency or duration of app usage. After 4 weeks, they were asked to complete the post-intervention survey via email. Once the web survey was complete, participants were interviewed over the phone by the primary researcher. The interviews were audio-recorded and were transcribed verbatim. Participants were rewarded with a $20 iTunes voucher for each completed survey and another for interview.

The primary researcher read the transcripts multiple times to get familiarised with the interview data. The data were coded and codes were collated and searched for themes and subthemes. The identified themes and subthemes were reviewed by the other authors and a consent was reached.

7.2.5 ANALYSIS

Repeated measures ANOVAs with two conditions (Smiling Mind; Cleveland Stress Free) and two occasions of measurement (Baseline, 4 weeks) were used to test differential changes between the apps on the three dependent measures (MHC-SF, CAMS-R, K10), and

individual responses were also explored. Interview transcripts were coded and analysed for themes and subthemes using inductive thematic analysis, following the procedure suggested by Braun and Clarke (2006).

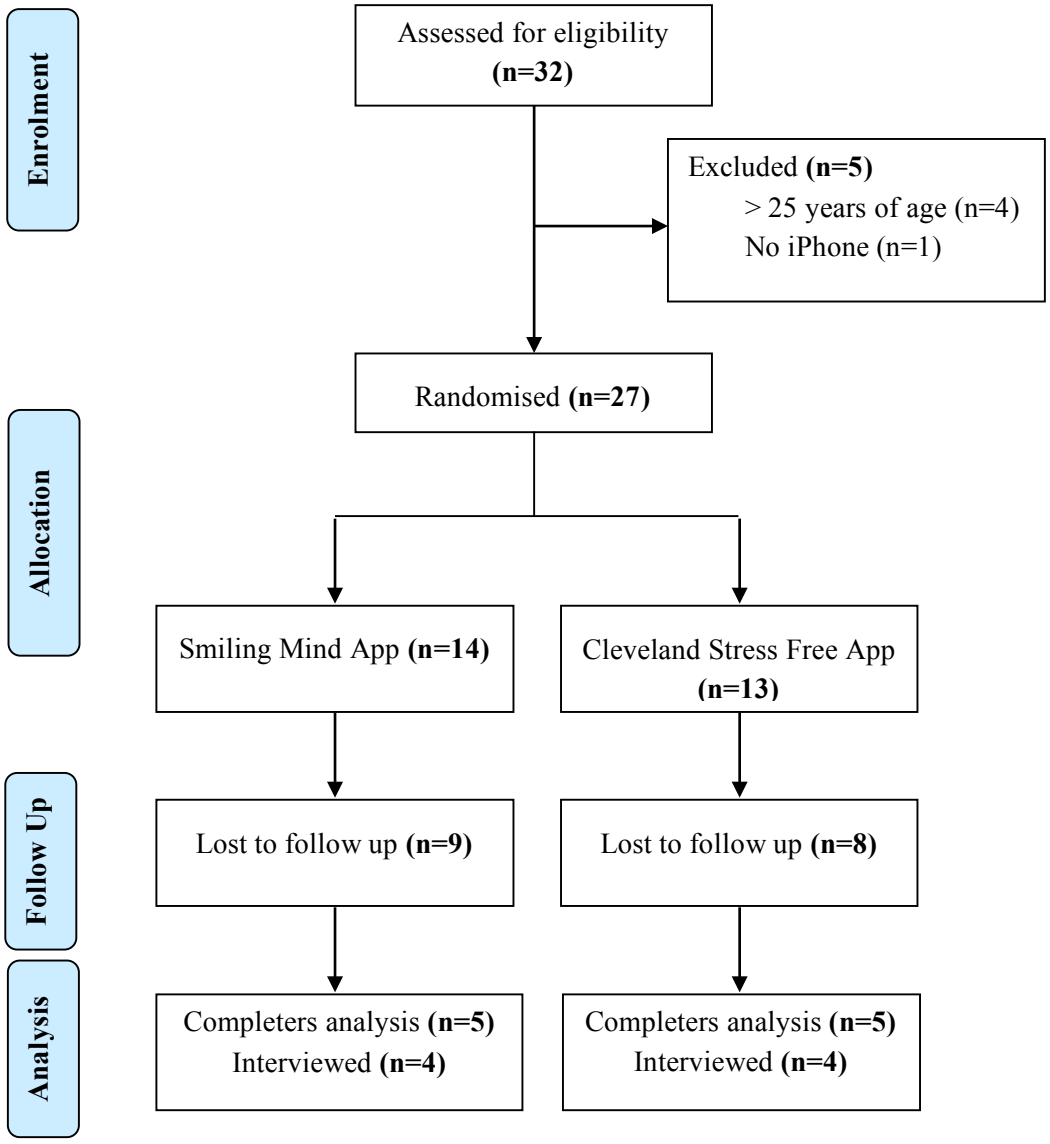

Figure 7 Consort Diagram – Study 2

7.2.6 RESULTS

7.2.7 RECRUITMENT AND SAMPLE CHARACTERISTICS

Thirty-two volunteers expressed interest. Three did not meet the age criteria and one did not have iPhone. The remaining 27 (9 males and 18 females) participated in the study.

Participants had a mean age of 20 years (SD = 3), two were high school students, one was employed and the remaining 24 were university students.

Only 10 of the 27 participants who were randomly allocated to a mindfulness app completed the post-intervention survey (37% retention). There was no response from the remaining participants despite multiple reminders and attempts to contact them. A CONSORT diagram is provided in Figure 7.

Table 4 Mean scores of outcome measures (completers; Study 2)

Measure	**Baseline** Mean (SD)			**Post-intervention** Mean (SD)		
	Total (n=10)	Smiling Mind (n=5)	Cleveland Stress Free (n=5)	Total (n=10)	Smiling Mind (n=5)	Cleveland Stress Free (n=5)
MHC	49.30 (11.16)	42.00 (9.16)	56.60 (7.92)	60.60 (12.69)	53.40 (10.31)	67.80 (11.23)
CAMS-R	30.90 (4.33)	29.80 (5.07)	32.00 (3.67)	32.80 (2.66)	32.60 (2.07)	33.00 (3.39)
K10	19.90 (6.44)	23.80 (5.58)	16.00 (4.89)	18.30 (5.46)	21.80 (4.44)	14.80 (4.09)

7.2.8 APP USAGE AND OUTCOMES

Participants who completed the 4-week post-intervention survey reported using the app a median of 3 times a week, ranging from a minimum of ‘at least once a week' (2 participants) to ‘5 times a week’ (1 participant). Their wellbeing scores (MHC-SF) were higher at baseline than those who dropped out of later assessments ($F(1,25) = 5.53$, $p = 0.027$).

Baseline and post-intervention scores for MHC-SF, CAMS-R and K10 are presented in Table 4. Across the sample, completers showed a significant increase in wellbeing over time ($F(1, 8) = 11.40$, $p = 0.01$, $d = 1.14$). However, there were no differential changes in wellbeing between the two groups ($F(1, 8) = 0.001$, $p = 0.977$), although changes in mean scores on the K10 and CAMS-R were in the expected direction (Table 4; K-10: $F(1,8) = 0.47$, $p = 0.512$, $d = 0.269$; CAMS-R: $F(1,8) = 1.12$, $p = 0.305$, $d = 0.544$).

7.2.9 INDIVIDUAL ANALYSES

Individual scores on the outcome measures are displayed in Figure 8. Both groups appeared to have two participants who had poorer results than the remainder (Smiling Mind: #8, 10; Cleveland Stress Free: #1, 6), and Cleveland Stress Free appeared to have one

participant (#2) who already had mindfulness skills, and had particularly strong improvements in wellbeing and distress.

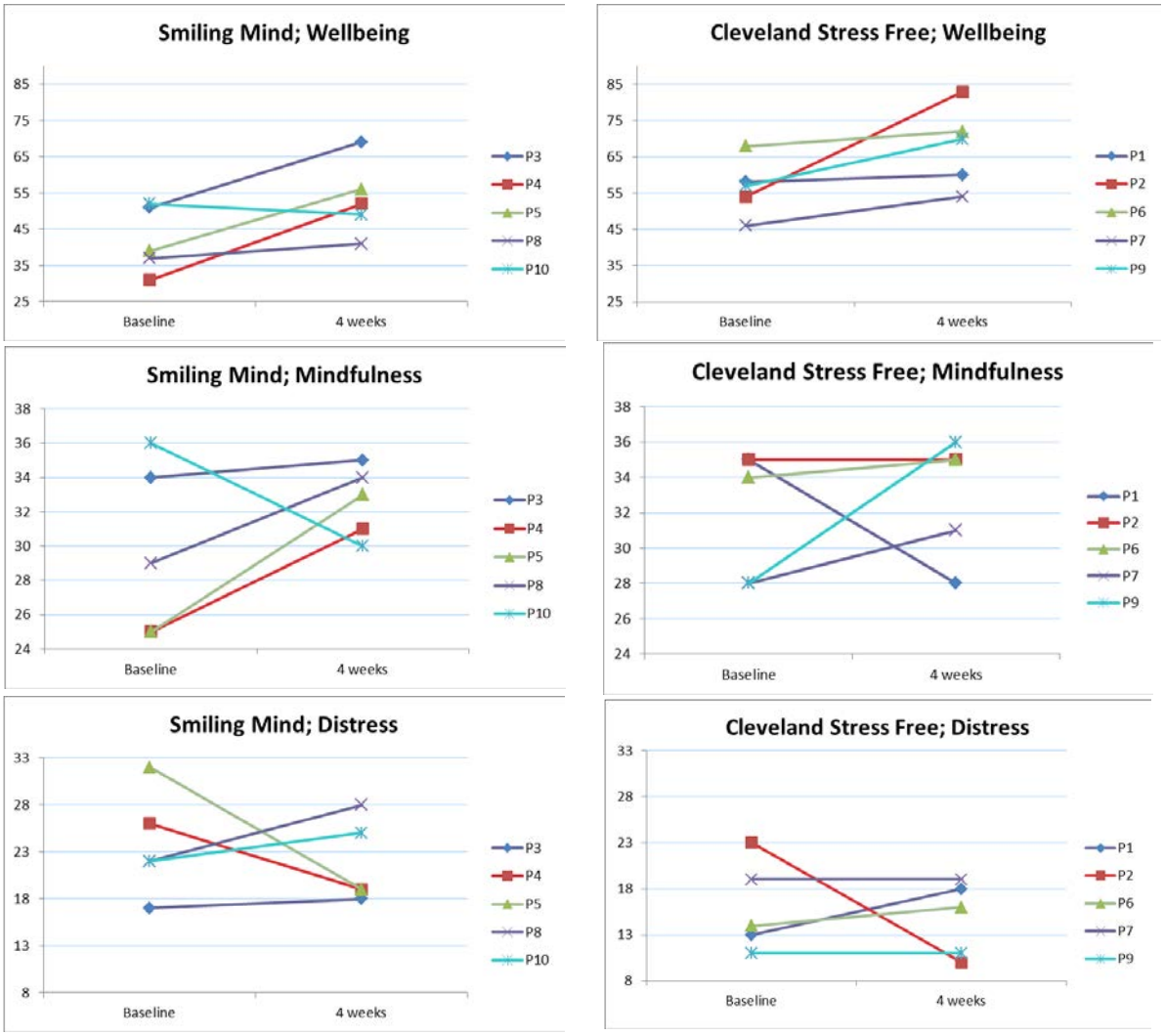

Figure 8 Individual plots for Mean scores of outcome measures (completers)

7.2.10 QUALITATIVE ANALYSIS

Participants did not report any previous experience in any face-to-face, web- or app-based mindfulness training prior to this study. Responses were typically very brief, and participants offered little additional information on further probing. However, the following themes were identified by thematic analysis.

7.2.10.1 **Conceptualization of mindfulness**

Present moment, awareness of surroundings, feelings

Participants perceived mindfulness to be living in the present moment, being aware of their surroundings, physical sensations and their feelings.

"Mindfulness is being aware of your surroundings and living in the present" – Participant 1

"focus on one thing or that would be like something in your surroundings or physical sensation" – Participant 4

"it's being self-aware and aware of the present moment" - Participant 7

However, there was a perceived need for improved understanding of the process and practice of mindfulness.

"they [young people] don't really understand the concept of it as a whole."- Participant 2

"…not many people know about it[mindfulness] or to use it properly." – Participant 4

Relaxing, Aids sleep

Some simplified mindfulness to be a relaxation or sleep inducing technique. Four out of the eight interviewed participants mentioned that they used the app just before going to bed.

"It's for sort of relaxation. Relieving of your stress" - Participant 4

"I used it before I go to bed at night [to] calm down at night." – Participant 1

"Before bed. That was definitely the best way." – Participant 6

7.2.10.2 **Motivation to practice mindfulness and to use app**

Six of the eight participants said that a better understanding of mindfulness and awareness of its benefits would motivate young people to practice more. Some also suggested that an introduction to mindfulness at a younger age may have benefit. Promotion within peer groups and propagation of mindfulness practice and benefits by celebrity ambassadors were mentioned as other potential motivating factors.

"…understanding the benefits of it, because I don't think most people realize how important it could be." – Participant 7

"there are so many benefits associated with mindfulness. I think if there is increased awareness people would definitely be more inclined to practice mindfulness…" – Participant 8

"You can say someone same as sort of celebrity is using it, that would get may be use it more. It's a big thing." – Participant 4

"I think if their friends are doing it, a lot of like, if your friends are getting into something and you think, that suits me, so promotion among their peer groups. Yeah." – Participant 8

7.2.10.3 **Helpful potential features of mindfulness apps**

Reminders

Seven of the eight interviewed participants mentioned reminders when asked about desired features in an app.

"Something like a little reminder definitely helps" – Participant 6

"I would most want the app to send me a reminder throughout the day like "hey you haven't done your mindfulness for the day"." – Participant 7

Structured approach of mindfulness training with increasing level of complexity

The Smiling Mind app had a structured mindfulness program, whereas the Cleveland stress free app presented a list of meditations that the user could choose in any order. The structured approach to mindfulness training was preferred.

"It kinda started out easy and then got into more difficult like meditation that you went up the level so. That was good as well." – Participant 1

"It can work your way through beginning to advanced sort of sessions." – Participant 4

"But I definitely think that there could have been a bit more improvement, for me one would have been structure." – Participant 8 (Cleveland stress free)

Soothing voice for guided meditations

Four participants mentioned a soothing voice as a feature they liked in the apps.

"I like the voice of the person doing the voice over, that was good." – Participant 1

"Like it's a nice voice to sort of listen to the girl that does all the sessions" – Participant 4

Comparing the two apps used in the study, Smiling Mind received more positive feedback from the participants.

"it was easy to use (…) I like how it also recorded how many meditations that you have done as well, so kind of felt like you are achieving something." – Participant 1

"…it had nice sort of interactivity and features. I think it really suited what the app was about." – Participant 2

"The topics they talked about were really simple topics but quiet effective." – Participant 3

Though the Cleveland stress free app was seen as useful, participants expressed the need for improvements.

"It could have been nice to have few different options but that was still enough of variety." – Participant 7

"…I definitely think that there could have been a bit more improvement." – Participant 8

7.3 DISCUSSION

7.3.1 PRINCIPAL RESULTS

To our knowledge, this is one of the first studies to compare the efficacy of two mindfulness apps. We sought to determine if a low- and high-quality mindfulness app, as identified by expert reviewers, differed in impact. The significant increase in mental wellbeing in completers from both groups may suggest that apps can potentially deliver mindfulness training effectively. Though the small sample size of this study warns us to interpret this result with caution, the mostly positive trend between pre- and post-intervention scores of individual's wellbeing and mindfulness outcomes in the exploratory analyses demonstrates the beneficial effect of the apps on the individuals. However, no differences in the wellbeing outcomes between participants randomised to the low- and high-quality app were found. It is therefore difficult to determine if these results indicate that the apps resulted in improved wellbeing outcomes, or whether the observed changes were due to another factor such as regression to the mean.

The qualitative interviews suggested that participants found the apps a convenient delivery medium for mindfulness training. The constant availability of apps was seen as a significant advantage for mindfulness practice, allowing its support at any time of the day.

There was little knowledge of mindfulness among participants. Mindfulness was seen as being aware of self, surroundings, feelings and sensations. However, while these aspects are essential parts of mindfulness, it is more than these (Hassed et al., 2006; Isenberg, 2009). No interviewee mentioned being non-judgmental and accepting of experience, and there seemed to be little clarity on mindfulness practices. Knowledge of mindfulness and its benefits may need to be heightened, if motivation to practice and resultant positive outcomes are to be optimized.

The high attrition rate may indicate participants had a lack of motivation to use the apps or practice mindfulness regularly, or could reflect a lack of commitment to the study itself. In face-to-face training, support groups have been found to encourage regular practice (Gunaratana, 2011). Brief ongoing coaching may also be beneficial. Incorporating such motivation and engagement measures in the design of the app may potentially improve app usage and mindfulness practice. Interactive, aesthetically pleasing and well-designed mobile apps are likely to be more effective in engaging the user in regular mindfulness practice as well (Cyr et al., 2006; Maghnati & Ling, 2013).

With regard to features in mindfulness apps, reminders were highly desired and perceived to be very helpful. Participants appeared to have difficulty making time for self-care, and app reminders may help them to incorporate mindfulness practice into their routines. A structured approach to mindfulness training (Smiling Mind) was clearly preferred by respondents to ad-hoc meditation sessions (Cleveland app). The positive feedback on Smiling Mind app and suggestions for improvement of Cleveland Stress Free app in the interviews were congruent with the MARS app quality rating of these apps (Mani et al., 2015). App quality is likely to affect both usage and degree of mindfulness practice, but further research is required to determine this.

The incidence of distress and mental disorders in young people is both very high and rising (McGorry et al., 2014). Six of the eight interviewees mentioned “stress” or related words like “busy”, “turbulent experiences”, “need to unwind” and “rush of the day” at least once. Mindfulness training, with mobile apps as delivery medium, may prove to be an effective antidote to this stress, if challenges with engagement and maintained practice can be solved.

7.3.2 STRENGTHS AND LIMITATIONS

This was one of the first mixed methods studies in mindfulness app research to examine quantitative outcomes as well as the subjective experiences of users. However, the conclusions of the quantitative study are limited by a small sample size and high attrition rate, which make it difficult to draw any conclusions about the efficacy of either app in this study. In order to trial the apps' impact in the natural environment, our study did not contact participants after distributing the allocated apps until post-assessment, but this probably led some participants to abandon the study. As most were university students, the high attrition rate could also be attributed to the fact that the study was conducted towards the end of a semester, when their focus was likely to be on examinations. Responses of participants in the qualitative interview were also limited in length and content, restricting the extent that they were informative. Respondents were restricted to those who remained willing to participate in assessments, which may have meant that some of their responses were more positive than those from other participants. It is also possible that a greater number of interview participants may have given additional themes.

7.4 CONCLUSIONS

While an increasing number of mindfulness apps are being developed, only two previous studies have examined the efficacy of mindfulness apps (Howells et al., 2014; Ly et al., 2014). Results of the current study suggest that mindfulness apps may have potential for improving wellbeing in young people, although trials with larger samples, improved retention and additional control groups are required to make confident conclusions about their efficacy.

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Professor Leanne Hides is supported by an Australian Research Council Future Fellowship.

Conflicts of Interest

None declared

7.5 COMMENTS

This study suffered a high attrition rate, highly limiting the outcomes. As noted in the paper, participants were not contacted during the intervention period. Previous studies have shown that better retention rates are achieved when there are more contacts between the research teams and the participants in trials that use mobile and internet technologies (Anguera et al., 2016; Murray et al., 2009). It remains a challenge in mHealth research to assess the impact of mobile app intervention in natural environment due to poor user engagement and high dropout rates when participants are not contacted during intervention period.

Chapter 8: Test of a mobile app for young people's mindfulness – A randomised controlled trial

Study 2, though limited by a low number of participants and a high attrition rate, demonstrated that mobile apps can deliver mindfulness training to young people with beneficial effects. Study 3 is the main randomised controlled trial of this research program. The high attrition rate in Study 2 and the outcomes of the interviews highlighted the need for motivation to maintain sustained use of the app and mindfulness practice. This informed the design of the main trial, which compared the effects of immediate access, immediate access with reminders and a 6-week delayed access to the Smiling Mind app. Though the pilot study measured wellbeing as the primary outcome and only distress and mindfulness as secondary outcomes of the intervention, Happiness measure (Oxford Happiness Questionnaire – Short Form) was included in the main trial to strengthen the test of efficacy of the app. Moreover, happiness data of young people were collected by other projects in the research group and this trial intended to provide happiness data to assist with reaching consensus.

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The following is the suggested format for the required declaration provided at the start of any thesis chapter which includes a co-authored publication.

The authors listed below have certified* that:

1. they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
2. they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
3. there are no other authors of the publication according to these criteria;
4. potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit, and
5. they agree to the use of the publication in the student's thesis and its publication on the Australasian Research Online database consistent with any limitations set by publisher requirements.

In the case of this chapter:

Test of a mobile app for young people's mindfulness – A randomised controlled trial

Contributor	Statement of contribution*
Madhavan Mani 25-Jul-2016	wrote the manuscript, experimental design, data collection and analysis
Prof David Kavanagh	aided experimental design, data analysis, and manuscript editing
Prof Leanne Hides	aided experimental design, data analysis, and manuscript editing
Wendell Cockshaw	data analysis

Principal Supervisor Confirmation

I have sighted email or other correspondence from all Co-authors confirming their certifying authorship.

DAVID KAVANAGH — Name

Signature — 25/7/16 — Date

Abstract

Background: Mobile applications (apps) have the potential to be effective platforms for delivering mindfulness training and promoting the wellbeing of young people. Despite the proliferation of mindfulness apps however, there is little evidence of their efficacy.

Objective: This randomised controlled trial compared the efficacy of immediate access, immediate access with reminders and 6-week delayed access to a high quality mindfulness app for improving the mental health and wellbeing of young people.

Methods: Eligible participants (16-25 years; n = 185), with at least mild distress, no prior mindfulness practice, and access to an iPhone or Android phone, were randomly allocated to Immediate access, Immediate access with Reminders or 6-week Delayed access to the Smiling Mind app. Participants in the Reminders group received weekly reminder calls for the first 6 weeks. Mental wellbeing (Mental Health Continuum-Short form), psychological distress (Kessler 10), cognitive and affective mindfulness skills (Cognitive and Affective Mindfulness Scale – Revised) and happiness (Oxford Happiness Questionnaire – Short Form) were measured at baseline, 6, 12 and 18 weeks post-Baseline.

Results: The Immediate group showed a significant improvement in wellbeing at 6 weeks, but the Delayed and Reminders groups showed little change from Baseline. However, from 6 to 12 weeks, the Delayed controls showed an equivalent improvement in wellbeing to that of Immediate access group in the first 6 weeks. The Reminders group did not differ from the Immediate access group at any timepoint. The whole sample showed a significant improvement in all outcome measures from Baseline to 18 weeks.

Conclusions: The Smiling Mind app improved the wellbeing of participants, but there was no advantage from provision of reminder calls. While a high-quality mindfulness mobile app can boost the wellbeing of young people, further research on the optimal frequency and content of reminder calls is needed.

Keywords: Mindfulness, mindfulness-based mobile apps, mindfulness apps, mHealth, health promotion, youth mental health

8.1 INTRODUCTION

Mindfulness-based interventions (MBIs) are gaining evidentiary support and popularity in both clinical and non-clinical settings (Grossman et al., 2004; Keng et al., 2011; Khoury et al., 2013b; Neff & Germer, 2013; M. Slade, 2010). Current evidence shows that MBIs can effectively treat a variety of psychological problems (Gu et al., 2015; Khoury et al., 2013b; Khoury et al., 2015) and result in improved quality of life (Coffey et al., 2010; Godfrin & van Heeringen, 2010; Josefsson et al., 2013). Mindfulness appears to be a suitable intervention modality for young people (Biegel, Brown, Shapiro, & Schubert, 2009; Perry-Parrish, Copeland-Linder, Webb, & Sibinga; Zoogman et al., 2014), who commonly experience substantial distress (Landstedt et al., 2016). A meta-analysis of mindfulness studies involving school children found large effects for improvements in psychological symptoms (Zoogman et al., 2014). A systematic review of MBIs for youth in school settings reported most studies found improvements in emotion regulation, social skills and optimism, in addition to reductions in depression, stress and anxiety (Felver, Celis-de Hoyos, Tezanos, & Singh, 2015). While randomised controlled trials on MBIs have varying effect sizes, overall the findings are positive (Zack, Saekow, Kelly, & Radke, 2014).

Outside of educational settings, there are significant challenges in delivering mindfulness training to young people. Multiple trials of web-based mindfulness training have found significant reductions in depression, anxiety and stress symptoms (Cavanagh et al., 2013; Mak et al., 2015; Messer et al., 2016). A recent meta-analysis which used a random effects model to compute the pre-post effect sizes of 15 randomised controlled trials on online MBIs targeting mental health (Spijkerman et al., 2016) found a small but significant beneficial impact on depression (g=0.29), anxiety (g=0.22), wellbeing (g=0.23) and mindfulness (g=0.32). The mean age of the participants of the studies ranged from 18 to 58 years and the intervention period varied from 2 to 12 weekly sessions.

Mobile phone applications (apps) offer an attractive, flexible and highly accessible medium for mindfulness training (Meeker, 2016), especially with young people. However, only three trials have examined the efficacy of mindfulness apps (Carissoli et al., 2015; Howells et al., 2014; Ly et al., 2014), none of which focused on young people. A randomised controlled trial of the 'Headspace On-The-Go' app among a self-selected sample of adults recruited online (n=194, M age = 40.7 years), found those who received the mindfulness app (n=57) had significantly greater increases in positive affect and decreases in depressive symptoms over 10 days of app use than controls (n=64) who logged their activities in a

generic app (Howells et al., 2014). However, no differential changes in negative affect, flourishing or satisfaction with life were found. Another randomised controlled trial (Carissoli et al., 2015), encouraged Italian adult volunteers (n=56, M age=38) to use a mindfulness app (''It's time to relax!'') or listen to relaxing music on their mobile for 18 days. A third group received no treatment over the period. No differential changes in self-reported stress were seen between the three experimental conditions at post-intervention. Both the trials only assessed outcomes at post treatment (10-18 days) and neither trial pre-selected participants with distress.

The other controlled trial randomised Swedish volunteers (n=81, M age=36) suffering from major depressive disorder to a behavioural activation (n=40) or mindfulness (n=41) app delivered over 8 weeks (Ly et al., 2014). The intervention included relevant web-based psychoeducation prior to app use and a maximum of 20-minute therapist contact per week per participant. There was no significant difference between the two interventions at post-treatment or at 6-month follow up, but large within-group reductions in depressive symptoms were found in both conditions. However, the absence of a no-treatment control condition weakens the findings.

The objective quality of the mindfulness apps used in these clinical trials was also not examined. Our recent review of mindfulness apps found wide variation in the quality of currently available apps (Mani et al., 2015). High levels of information quality (mindfulness education and training), usability and attractiveness are prerequisites for a strong test of the effects of mindfulness apps.

The current randomised controlled trial tested the efficacy of the Smiling Mind app, a high-quality mindfulness app identified in our previous review, in a cohort of young people who were experiencing at least mild levels of distress. Participants were randomised to receive Immediate access, Immediate access with phoned Reminders to practice, or 6-week Delayed access to the Smiling Mind app. Effects on distress and wellbeing were assessed at 6, 12 and 18 weeks.

8.2 METHODS

8.2.1 PARTICIPANTS

The study was advertised through university mailing lists, the social media links of the Young and Well Cooperative Research Centre and the student group Facebook pages of Australian Universities and schools. Participants were required to be 16-25 years old,

experience at least mild level of distress, have access to an Android phone or iPhone and have no prior mindfulness practice.

8.2.2 MEASURES

8.2.2.1 Mental Health Continuum–Short Form (MHC–SF)

The 14-item MHC–SF (Lamers et al., 2011) measures the degree of (1) Emotional wellbeing (items 1–3; defined in terms of positive affect and satisfaction with life); (2) Social Wellbeing (items 4–8: social acceptance, social actualization, social contribution, social coherence and social integration); and (3) Psychological Wellbeing (items 9–14: autonomy, environmental mastery, personal growth, positive relations with others, purpose in life and self-acceptance). The MHC-SF was found to have high levels of reliability ($\alpha > .80$) among an adolescent sample (Guo et al., 2015).

8.2.2.2 Kessler-10 (K10)

The K10 (R. C. Kessler et al., 2003) is a well-validated 10-item measure of the frequency of anxiety and depression symptoms experienced in the previous 4 weeks. Items are rated on a 5-point Likert scale and are summed to give total scores representing low (10-15), medium (16-29) or high (30-50) risk of depressive symptoms. The scale was found to be highly reliable ($\alpha = .93$) for general population (R. C. Kessler et al., 2003).

8.2.2.3 Cognitive and Affective Mindfulness Scale-Revised (CAMS-R)

The 12-item CAMS-R (Feldman et al., 2007) measures the four domains of mindfulness (attention, present-focus, awareness, acceptance). Items are rated on a Likert scale from 1 (rarely/not at all) to 4 (almost always). Higher scores reflect greater mindfulness. The measure demonstrates acceptable internal consistency and convergent validity with similar measures when administered to university students (Feldman et al., 2007).

8.2.2.4 Oxford Happiness Questionnaire – Short Form (OHQ-SF)

The OHQ-SF (Hills & Argyle, 2002) has 8 items from the Oxford Happiness Questionnaire that correlate highly with the full scale ($r = .90$). The scale measures aspects of happiness on a 6-point Likert scale. It has moderate internal consistency ($\alpha > .57$) and satisfactory short-term test-retest reliability among undergraduate university students (Cruise, Lewis, & Guckin, 2006).

8.2.3 PROCEDURE

The Human Research Ethics Committee from Queensland University of Technology approved the study (1400000827). Eligible participants were recruited via email to complete a web-based survey containing the MHC-SF, K10, CAMS-R and OHQ-SF. Respondents who completed the baseline survey were randomly allocated to the Immediate, Reminders or Delayed groups using a web-based research management tool. All participants were informed of their allocation via email. The two immediate access groups were sent the link to the app after completing the Baseline assessment and asked to use it. Participants were not advised how often they should use the app. The Delayed group received the app after 6 weeks. Participants in the Reminder group were called weekly for the first 6 weeks by the primary researcher. They were encouraged to share their experience with mindfulness practice and app usage in the previous week and were reminded about the importance of regular practice to gain the benefits of mindfulness. The calls lasted for around 5 minutes. All three groups were asked to complete follow-up surveys at 6, 12 and 18 weeks via email. If necessary, reminders to complete the survey were sent via SMS and emails. Participants received a $20 iTunes voucher for completing each survey.

8.2.3.1 **Analysis**

Linear mixed models were used to analyse outcomes, allowing intention-to-treat analyses without prediction of missing data. Two analyses were applied to each outcome variable: from Baseline to 6 weeks (where time by group interaction indicates the effect of treatment) and from Baseline to 12 and 18 weeks. Mental wellbeing (MHC-SF) was the primary outcome variable; distress (K10), cognitive and affective mindfulness skills (CAMS-R) and happiness (OHQ–SF) were secondary. A Toeplitz autoregressive covariance structure was specified, since it gave the best fit to the data. Effect sizes were measured as changes from baseline in baseline standard deviation units.

8.3 RESULTS

8.3.1 RECRUITMENT AND SAMPLE CHARACTERISTICS

Advertising in Universities' Facebook pages attracted most volunteers for the trial. While 294 volunteers expressed interest (Figure 9), 48 did not complete baseline assessments, 20 did not meet the age criteria, 25 had low distress, 14 had prior formal mindfulness practice and 2 did not have smartphones. The remaining 185 (122 female, M age = 20.61, SD = 2.54;

63 males, M age = 20.63; SD = 2.53) participants were randomly allocated to Immediate (n = 62), Reminders (n = 62) or Delayed access (n = 61) groups. Baseline measures are presented in Table 5. There were no significant differences between the groups on age, gender or education. Follow-up rates were 85% (n = 158), 82% (n = 151) and 75% (n = 135) respectively at 6, 12 and 18 weeks respectively.

8.3.2 APP USAGE

The immediate groups reported using the app a median of 12 times (interquartile range: 6 - 18) in the first 6 six weeks. All participants reported using the app a median of 6 times in the second (interquartile range: 1.5 – 12) and third (interquartile range: 0 – 12) 6 week time periods of the study. The groups did not differ significantly in app use at 6, 12 or 18 weeks.

8.3.3 OUTCOME MEASURES

Descriptive statistics are summarised in Table 6. There were no significant differences between the three groups on the Baseline outcome measures. The results of mixed models analyses are reported in Table 7. Over the first 6 weeks, the wellbeing measure (MHC-SF) showed a significant time by group interaction (Table 7). The wellbeing of the Immediate access group improved significantly over the first 6 weeks ($F=11.54$, $P< .001$, $d=0.34$), while the Reminders and Delayed groups showed little change. Other outcome measures showed significant improvements over time, but no differential changes between groups were found (Table 7).

Secondary analyses examining the degree of change over the first 6 weeks of app use (i.e. from Baseline to 6 weeks for the Immediate access group, and from 6 to 12 weeks for the Delayed group) showed that the Delayed access group achieved an equivalent improvement ($F=10.18$, $P=.002$, $d=0.33$), to the Immediate access group on wellbeing. Comparing baseline to 12 and 18 follow-up assessments, all outcome measures showed significant improvement over time, but no time by group interactions were found (Table 7).

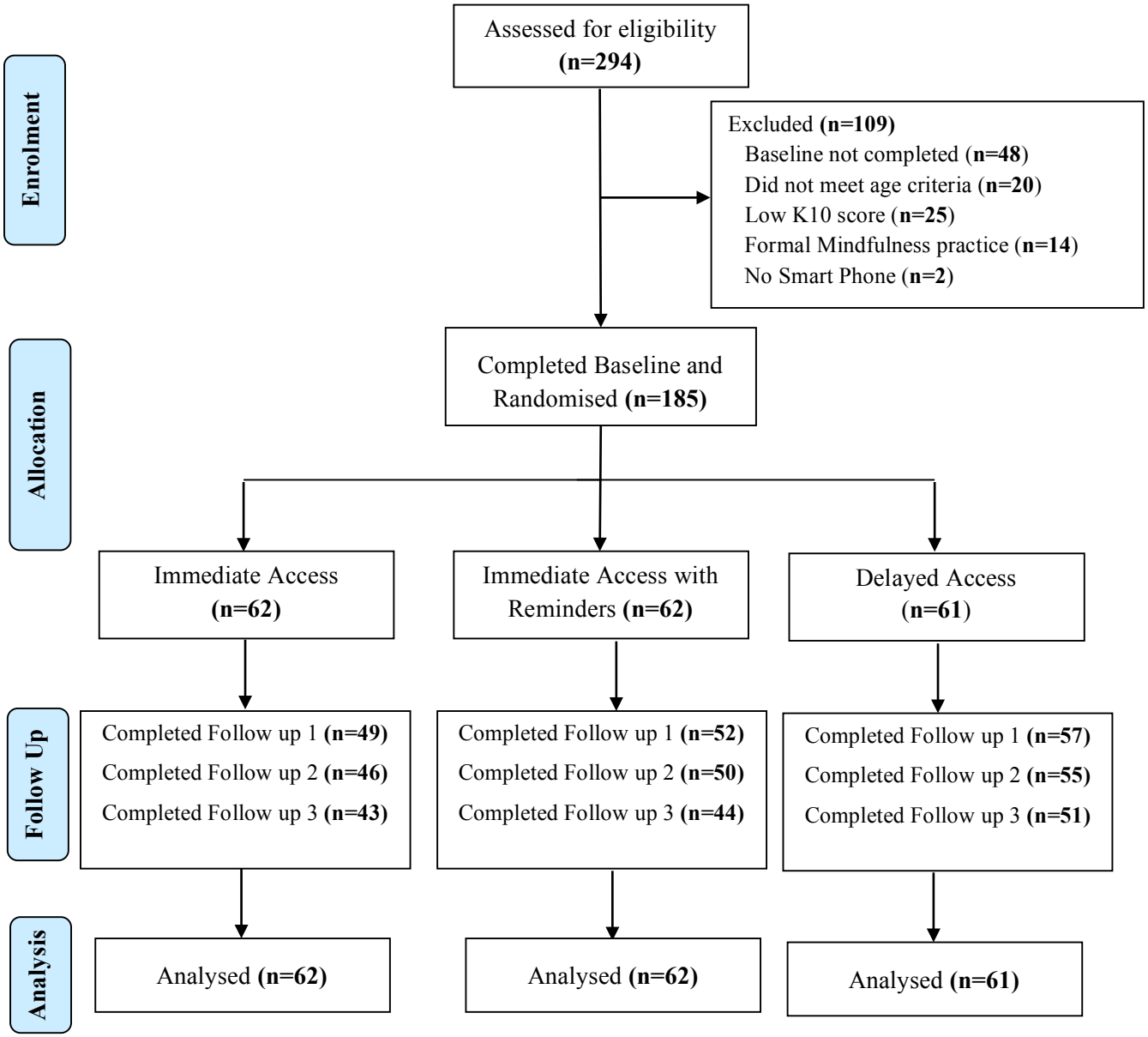

Figure 9 Consort Diagram – Study 3

Table 5 Baseline characteristics of all three groups (Study 3)

		Immediate	Reminders	Delayed	Total
Demographic variables					
Male Gender	% (n)	32 (20)	35 (22)	34 (21)	34 (63)
Age	M (SD)	20.61 (2.56)	20.47 (2.43)	20.79 (2.65)	20.62 (2.53)
Education					
Bachelor or higher	% (n)	32 (20)	23 (14)	18 (11)	24 (45)
High school/Cert III-IV/Diploma	% (n)	68 (42)	77 (48)	79 (48)	75 (138)
No formal education		-	-	3 (2)	1 (2)

Table 6 Descriptive statistics (Study 3)

Measure	Group	Baseline Mean (SD)	6 weeks Mean (SD)	12 weeks Mean (SD)	18 weeks Mean (SD)
MHC	Immediate	37.24 (13.07)	41.47 (11.67)	41.35 (14.23)	41.65 (12.75)
	Reminders	41.65 (13.27)	42.52 (12.08)	43.38 (13.69)	44.14 (14.20)
	Delayed	37.54 (11.86)	36.67 (13.08)	41.13 (14.25)	43.20 (14.12)
	Total	38.82 (12.84)	40.08 (12.53)	41.94 (14.00)	43.01 (13.67)
K10	Immediate	25.35 (5.90)	21.92 (6.79)	22.96 (7.48)	21.07 (5.59)
	Reminders	24.52 (6.50)	21.44 (6.91)	21.5 (7.00)	21.02 (6.97)
	Delayed	24.82 (5.83)	23.46 (6.20)	22.00 (6.37)	21.25 (7.11)
	Total	24.90 (6.06)	22.32 (6.64)	22.13 (6.91)	21.12 (6.58)
CAMSR	Immediate	28.87 (4.94)	29.71 (5.55)	31.00 (5.49)	30.28 (6.12)
	Reminders	29.29 (5.29)	30.50 (4.99)	32.16 (5.91)	31.57 (5.49)
	Delayed	28.07 (4.67)	28.58 (5.34)	30.56 (5.47)	31.82 (4.97)
	Total	28.75 (4.97)	29.56 (5.32)	31.23 (5.63)	31.26 (5.51)
OHQ	Immediate	29.79 (6.30)	30.53 (6.29)	30.48 (6.48)	30.53 (5.93)
	Reminders	30.34 (6.02)	31.65 (6.99)	32.40 (7.10)	31.95 (6.38)
	Delayed	27.79 (7.19)	28.86 (6.78)	30.84 (7.54)	31.43 (7.24)
	Total	29.31 (6.58)	30.30 (6.77)	31.25 (7.09)	31.32 (6.56)

Table 7 Linear Mixed Model analysis - outcome measures (Study 3)

	Baseline - 6 weeks						**Baseline - 12,18 weeks**					
	Time			Time by group			Time			Time by group		
	F	*df*	*P*	*F*	*df*	*P*	*F*	*df*	*P*	*F*	*df*	*P*
MHC-SF	3.88	1,162	.05	4.23	2,162	.016	13.04	2,209	< .001	0.88	4,209	.474
K10	31.01	1,162	<.001	1.94	2,162	.147	27.87	2,231	< .001	0.37	4,231	.827
CAMSR	5.03	1,166	.026	0.20	2,166	.817	25.68	2,236	< .001	2.12	4,236	.079
OHQ-SF	6.10	1,161	.015	0.027	2,161	.970	13.65	2,223	< .001	2.19	4,223	.071

8.4 DISCUSSION

8.4.1 PRINCIPAL RESULTS

This study is the largest randomised controlled trial of a mindfulness app with young people to date, examined over the longest duration (18 weeks). It is also the first trial to test

the impact of a high-quality app, and whether reminder calls to practise mindfulness using the app improved its outcomes. Randomisation was automated and independent, and the outcome measures were psychometrically sound and completed online to avoid assessment bias.

Significant group by time effects over the critical initial control period of 6 weeks were found for wellbeing, although differential benefits from the app were only found for the group who did not receive reminders. While the whole sample demonstrated reduction in distress and improvements in mindfulness and happiness, no differential effects on these measures were seen. These differential findings are consistent with previous research finding weak or inconsistent results (Carissoli et al., 2015; Howells et al., 2014; Ly et al., 2014).

The absence of a benefit from the provision of telephone reminders was particularly surprising, given that reminders constitute one of the most desired features in mindfulness apps (Mani, Kavanagh, & Hides, 2016), and that might be expected to facilitate both app use and mindfulness practice. The high baseline wellbeing score of the Reminders group may have created a ceiling effect, reducing the opportunity for the app to improve wellbeing. It is possible that the reminders became aversive to some participants, particularly if they had not been practising, although they were delivered in a non-judgmental style. Particularly noteworthy, was that participants in the Reminders group had the lowest use of the app between 12 and 18 weeks. One possibility was that they attributed their use over the initial 6 weeks to the presence of reminders, decreasing the longevity of their use.

A larger sample size, a greater intensity of reminder calls, or different call content (e.g. a focus on personalised assistance in solving problems with mindfulness practice) may be needed to detect effects of this support. Reminder calls may also need to emphasize self-regulation to improve maintenance of effects.

While continued mindfulness practice is essential to maintain its benefits (Bergomi, Tschacher, & Kupper, 2015; Volanen et al., 2015), it is challenging, especially for beginners (Gunaratana, 2011). Face-to-face mindfulness training has the advantage of social support from trainers and peers, which encourages regular practice (Gunaratana, 2011). Effective delivery of mindfulness training and maintenance of practice through mobile apps may continue to be a challenge. However, the high rate of maintained app use in this study indicates that mobile apps have the potential to be an effective medium for delivering mindfulness-based interventions.

Health-related apps can be a viable and cost-effective medium for intervention delivery in clinical and non-clinical settings (Luxton et al., 2011; Marzano et al., 2015; Preziosa et al., 2009). Already there are more than 165,000 apps directly available to public, and numbers are increasing exponentially (John Torous & Firth, 2016). Despite little evidence for the efficacy of health-care apps (Donker et al., 2013; John Torous & Powell, 2015), many are widely used. There is an urgent need for additional trials and for their results to be disseminated to users, so they can make informed decisions about app use.

8.4.2 LIMITATIONS

Since this research used an existing app and the app company was unable to provide objective information on app usage, our usage data relied on self-reports. It is possible that this led to overestimates of usage, and future trials should use data directly downloaded from apps to avoid this possibility.

8.5 CONCLUSIONS

Mobile apps may potentially provide an effective strategy for delivery of mindfulness training, with advantages of wider reach and lower cost compared with face-to-face sessions. The current study provides preliminary support for the use of a high-quality mindfulness mobile app to improve the wellbeing of young people, but further high-quality research is needed to increase confidence in these results and further examine the potential role of coaching or reminders.

Acknowledgements

This project was funded by the Young and Well Cooperative Research Centre (Young and Well CRC). The Young and Well CRC is an Australian-based, international research centre that unites young people with researchers, practitioners, innovators and policy-makers from over 70 partner organisations. Together, we explore the role of technology in young people's lives, and how it can be used to improve the mental health and wellbeing of young people aged 12 to 25. The Young and Well CRC is established under the Australian Government's Cooperative Research Centres Program.

Associate Professor Leanne Hides is supported by an Australian Research Council Future Fellowship.

Conflicts of Interest

None declared.

8.6 COMMENTS

Social media, particularly Facebook, was found to be effective for recruiting participants of this study. More than 90% of the participants were recruited through official and unofficial student group Facebook pages of universities and some schools. Most universities have 'Stalkerspace' student groups which are moderated by student community and have huge memberships (e.g. UQ Stalkerspace Facebook group has more than 39,000 members at the time of writing this thesis). Young people's interest and presence in multiple social platforms (Facebook, Twitter, Instagram, etc.) and the ever growing social media make it a potential resource for researchers.

The wellbeing score of the immediate access group steeply increased from baseline to 6 weeks and was maintained at 12 and 18 weeks, while the reminders group showed steady increase from baseline to all three follow ups. Similarly, the mindfulness scores of both immediate access and reminders group steadily increased from baseline to 6 and 12 weeks, but decreased at 18 weeks. This raises a concern on the efficacy of the app in improving and maintaining the outcome effects for long term. Larger trials with longer periods of follow-ups are needed to assess the long term effects.

Unlike Study 2, this study had good retention rate throughout, and the retention rate did not differ between groups. However, the reminders group did not differ from the immediate access group on any outcomes. The effects of frequency and contents of reminders on app usage and resultant outcomes require further investigation.

Chapter 9: General discussion

This research program was a modest attempt to address the global crisis of youth mental health issues. As highlighted in chapter 2, the problem and hence the potential resolution are multi-fold, requiring an ecological understanding; it involves different layers of the ecology: individual (e.g. vulnerable age, help-seeking attitude), family and community (identification of mental health problems, social support), and health care policies and systems (models of delivery, parity of esteem between physical and mental health, health promotion, prevention). This demands collaborative efforts from policy makers, researchers, clinicians, mental health service providers and technologists, and calls for innovative approaches to meet the manifold complex needs of youth effectively. A combination of stepped care (Figure 10) and e-mental health may help to address these needs. In the stepped-care approach to mental health interventions, priority access to high-intensity interventions is given to people with more urgent, serious or complex conditions. Thus, resource utilisation is based on the complexity of need. It may especially suit integration of technology in delivery at various levels (Coyle & Doherty, 2010; Hosie et al., 2014; Klein et al.; van Straten, Hill, Richards, & Cuijpers, 2015; van't Veer-Tazelaar et al., 2010). Online and mobile app interventions may be more appropriate and cost-effective for prevention and promotion programs and may potentially serve as an adjunct to clinical interventions.

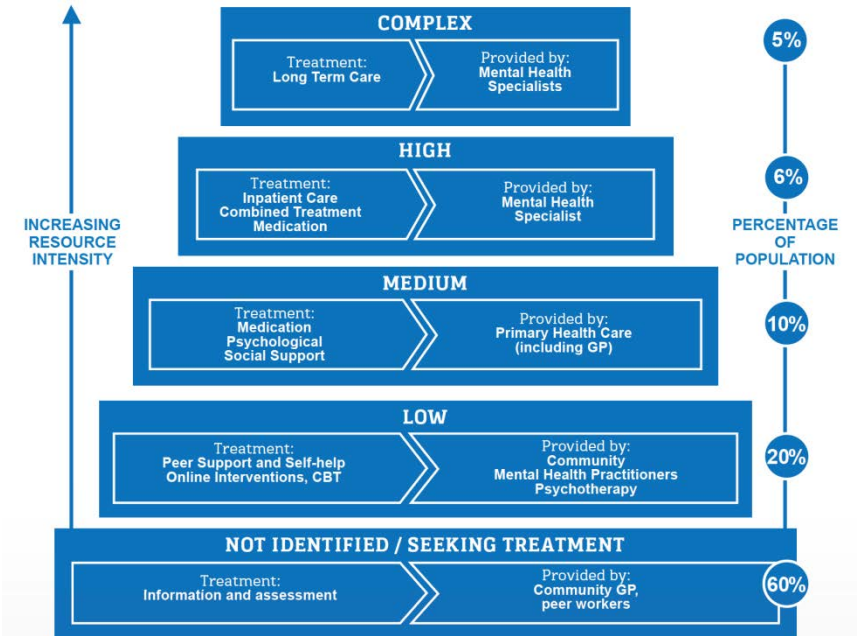

Figure 10 Stepped care model
Adapted from Hosie et al. (2014)

9.1 YOUTH MENTAL HEALTH

Mental health problems of young people can create a negative lifetime impact for the person and also affect the community in terms of social and economic costs. Strong advocacy of early prevention and health promotion to build a healthier society and more productive youth is needed. In a global survey among young people (age 10-24), better health ranked third in priority in sustainable development agenda (Gupta et al., 2014). When participants in this research program were interviewed, they indicated that they were looking for ways to handle stress, sleep disorders, anxiety and similar psychological problems. Identifying their needs and limitations and adapting the health care services accordingly may help this vulnerable age group.

Interventions may need to be tailored according to young people's preferences for therapy if their engagement is to be optimised (Watsford & Rickwood, 2015). Increased mental health literacy (MHL) and decreased stigma are identified as two essential components to improve the help seeking attitude of young people (Kelly, Jorm, & Wright, 2007; Kutcher et al., 2016). Accordingly, confidentiality and trust in the provider and support and encouragement from others may be needed to facilitate maximal help-seeking in this group (Gulliver et al., 2010). Reformed models of health care delivery that integrate eMH have potential to address these requirements.

Mindfulness practice has potential to be both a preventive and curative intervention for youth mental health, and the large and growing volume of scientific literature on the benefits of mindfulness is in support of this contention. Further support is offered by the current research program, particularly in relation to the differential improvement in wellbeing that was evidenced in the second trial.

9.2 STUDY FINDINGS AND IMPLICATIONS

9.2.1 STUDY 1

The increasing volume of health care apps available in the market poses a challenge for both researchers and normal users (Dalkou et al., 2015; Meurk et al., 2016; Nagappan & Shihab, 2016; Price et al., 2014). It is particularly difficult to identify a high-quality app, as there are no reliable quality assessments that are provided in app stores or widely used websites. Furthermore, as Study 1 in the current research program demonstrated, a large number of available apps do not meet basic criteria for being fit for purpose. Tools like the MARS, which was used in Study 1 for evaluating apps, would provide significant assistance

to potential users, if they were routinely offered. Ratings by potential users on a measure such as the user version of the MARS (uMARS; Stoyanov, Hides, Kavanagh, & Wilson, 2016) may provide an alternative with even higher perceived relevance and would also have high credibility if it were conducted independently. Either measure would offer a substantial improvement on app stores' current star ratings, which are insufficiently articulated and open to manipulation by developers.

There are initiatives to build repositories of health intervention apps (for example, https://au.reachout.com/sites/thetoolbox, www.psyberguide.org, https://beacon.anu.edu.au). Xu et al (2015) have created a repository for mhealth apps available in certain geographies. The data is freely available on request for personal and non-commercial purpose. Such repositories or similar services that list mHealth apps will make it considerably easier for practitioners to integrate mHealth into their practice.

Study 1 highlighted the lack of engagement factor in the existing mindfulness apps. In addition to the lack of evidence for efficacy, most apps are not based on any psychological theory. Sustained behaviour change is essential for any health improvements and is a major challenge to attain in health care apps (M. Patel et al., 2015). Apps may leverage the principles of behaviour change theories to positive effect, which is currently lacking, (Conroy, Yang, & Maher, 2014; Pagoto & Bennett, 2013). As highlighted earlier, cognitive-behavioral therapies have potential to be successfully delivered on mobile platforms. Since the majority of mobile apps that are downloaded and used involve games or social networking (Mackay, 2014), health care apps can adopt relevant features from these categories to enable wider reach. These may help create quality mhealth apps that are likely to gain more evidence for efficacy and acceptance from wider community.

Research in mHealth has a unique challenge. The rapid pace of development in technology outstrips the slow pace of traditional research methodologies. Most of the mindfulness apps that were reviewed and evaluated in Study 1 were upgraded to higher versions when the research was published. Apps have short development life cycle. mHealth researchers should consider these factors when designing and executing research, as should practitioners and other users who are choosing between apps. Methodologies like 'Research in the large' are starting to address some of these concerns.

Success of mHealth apps heavily depends on collaborative efforts from app developers, designers, researchers, practitioners, policy makers and consumers. Traditional methodologies of development and evaluation of mHealth apps need to be revamped to make such

collaboration effective in rapidly delivering resources that are responsive and effective. Some additional key features and processes have been identified. Interactive mobile applications are likely to be more effective than those that only disseminate information (Riley et al., 2011), and multiplatform development has become essential, with the proliferation of devices with different functionality and screen size. Participatory research design, where young people are engaged at all stages of development, testing and ongoing evaluation, has also emerged as a cornerstone to building an app's acceptance, usability, uptake and impact (Muir, Powell, & McDermott, 2012). Finally, a sustained funding stream is needed to ensure that the best apps are compatible with new devises and operating systems and meet the increasing demands of users. Combining these strategies with agile research methodologies and effective dissemination of their results will help to ensure that effective health apps are quickly developed and widely used.

9.2.2 STUDY 2

The health outcomes of this study, though positive for the whole cohort, did not differ between the high- and low-quality app. However, the results should be interpreted with caution, as the study had a high attrition rate and a short intervention period. It is possible that both apps had an impact, but without a control group, the observed improvements could be attributed to other factors. Rigorous research is needed to test the impact of quality of apps on efficacy, especially with mindfulness apps.

Reminders were reported to be the most sought feature in a mindfulness app in the participant interviews in Study 2. Alert features in the form of short motivational messages ('Snippets') sent via email or SMS were perceived to have significant impact on anxiety symptom reduction in a trial that aimed to identify impact of patterns of program usage on treatment outcome measures of 'myCompass', a mobile friendly web-based program (Whitton et al., 2015). Alerts and symptom tracking were found to be the most used features of the program. While phone reminders in Study 3 in this research program did not provide any significant difference, if SMSs were used to both remind participants to practice and to give brief tips and encouragement, greater impact may be seen.

mHealth interventions seem to be more successful when they are personalised, interactive and are aimed at increasing social support and knowledge (Tossell, Kortum, Shepard, Rahmati, & Zhong, 2012; Whittaker, Merry, Dorey, et al., 2012). If they create a virtual social network, their reach and impact may be further increased (Luck & Mathews,

2010). Users are committed to achieving their goals when they share their goals or compete for goals with an audience or group (Cialdini, 2009; Locke & Latham, 2002). Communicating goals on social networks such as Facebook and competing or collaborating with others increases the likelihood of an intention to enact behavior change (Bandura, 1998, 2004). Moreover, social factors have a profound impact on our behaviour, and are huge determinants in our overall health (Holt-Lunstad, Smith, & Layton, 2010; Lieberman, 2013; Uchino, Uno, & Holt-Lunstad, 1999). Involving young people in the development of the intervention program may encourage them to use the intervention more (Rickwood et al., 2007).

9.2.3 STUDY 3

Smiling mind app improved wellbeing of the participants in this study. The wellbeing outcome differed between groups in the critical first six weeks and significant improvement in all groups at follow ups strongly suggests the efficacy of the app. This adds to the emerging efficacy literature on mobile apps intervention. Effective mobile apps can be used as adjunct to other clinical conditions to enhance the efficacy (Messer et al., 2016).

Mobile apps were found to be well-suited to deliver mindfulness training to young people. However, while it is feasible to deliver mindfulness training through an app, motivating users to continue to use the app regularly remains a challenge. This research program was limited in its ability to examine the degree of use and its determinants, because usage details could not be obtained from the app owners. Nor was the research able to shed further light on features to maintain use, such as feedback on personal or competitive achievements, or incentives such as privileged feature access. However, it is expected that maintained use of a mindfulness app will be reliant on demonstrated benefits for the individual from their mindfulness practice and on whether the app is perceived to have a critical role in achieving those benefits. It is not clear that the features of the studied app were sufficiently powerful to achieve these ends.

This study relied on self-reports for assessing outcome measures and app usage. Technological advancements of mobile devices (like sensors, GPS, etc.) that facilitate automated ecological momentary assessment (EMA) in real-time and real-world contexts (Whitton et al., 2015), may be further leveraged by mindfulness apps (for example, by detecting and giving feedback on mindfulness practice, based on psychophysiological recording).

Internet, Social Media and technology have huge potential for multiple aspects of research (Brice, Price, & Burls, 2015). Social media proved to be an effective recruitment pool for Study 3 in this research program. The web-based management tools for research (Goji) and survey (Qualtrics) and their integration were very beneficial in many ways in conducting Study 3 of this research program. Researchers can leverage these internet and other related technologies, especially for research involving young people, to their advantage. Social marketing campaigns conducted online, including via social networking services can now reach a large population, at a fraction of the cost of more traditional strategies. The flexibility of mobile devices and the expanding development of apps offer new opportunities for innovative campaigns and new ways to deliver information and support that can be explored for research in health promotion and health care in general, especially among young people (Hosie et al., 2014).

mHealth apps are gaining more attention among consumers, mental health service providers and researchers. While there are multiple channels of distribution and delivery of

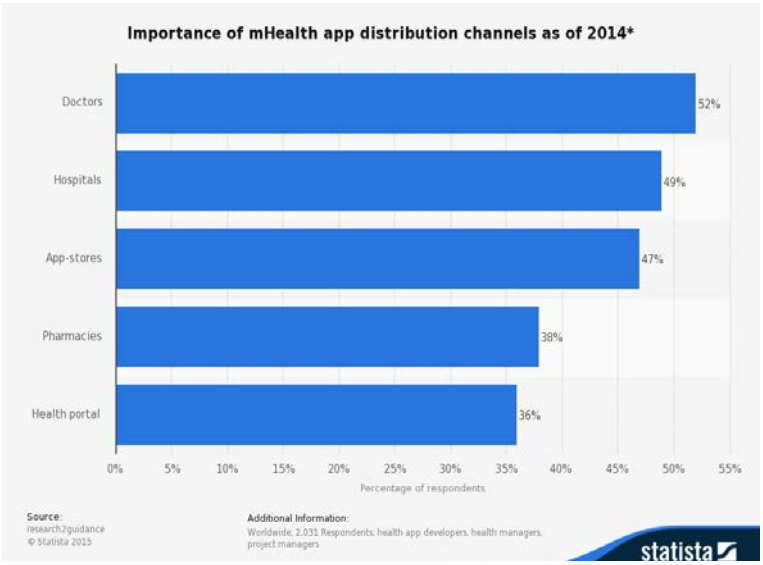

Figure 11 Importance of mHealth app distribution channels - 2014

health care apps, clinicians and hospitals were the most expected distribution channels (Figure 11). Additional research such as the work in this research program, which evaluates mHealth will further improve the confidence of clinicians to integrate health care apps with their regular treatment, if it clearly demonstrates that mHealth has impact. Trials that integrate mHealth into routine care has particular promise in this regard, both because it may help to reduce problems with insufficient use of the interventions by patients, and because these trials will be seen to have substantial relevance to practitioners.

9.3 STRENGTHS AND LIMITATIONS

None of the existing few trials on mindfulness apps pre-selected participants with distress, the methodology of previous studies was weak, and the objective quality of the mindfulness apps used in those clinical trials was not reported. The current research program systematically reviewed and evaluated the subjective quality of existing mindfulness apps with an expert rating tool and tested a high-quality app in a controlled trial. The overall methodology of this research program is its biggest strength.

Study 1 was one of the first to review mindfulness-based iPhone apps, and it was the first to evaluate their quality using a psychometrically sound and multidimensional expert rating scale. However, it was limited to iPhone iOS apps, indicating future research is required to review and rate the quality of Android apps. Such research could also go a step further than our study, by analysing the contents of the apps and the quality of their guided meditation tracks. Study 2 was one of the first mixed methods studies in mindfulness app research to examine quantitative outcomes as well as the subjective experiences of users. In order to test the apps' impact in the natural environment, as a pragmatic trial, Study 2 did not contact participants after distributing the allocated apps until post-assessment, but this probably led some participants to abandon the study. The small sample size and the high-attrition rate imposed a significant limitation on the analysis of power and calculating effect size. As most were university students, the high attrition rate could also be attributed to the fact that the study was conducted towards the end of a semester, when their focus was likely to be on examinations. Responses of participants in the qualitative interview were also limited in length and content, restricting the extent that they were informative. Respondents were restricted to those who remained willing to participate in assessments, which may have meant that some of their responses were more positive than those from other participants. It is also possible that a greater number of interview participants may have given additional themes. While the study was limited by these features, it provided important information to guide the later trial, which had substantially improved methodology.

Since this research used an existing app and the app company was unable to provide objective information on app usage, our usage data relied on self-reports. It is possible that this led to overestimates of usage, and future trials should use data directly downloaded from apps to avoid this possibility.

9.4 FUTURE DIRECTIONS

This research program has highlighted the need for further research in multiple areas. The mismatch between the slow pace of research and the fast pace of technology demands innovative research methodologies in mHealth. While technology already plays a significant part (e.g. integrated research management, survey and randomisation tools, automated reminders, etc.), a better integration of the research process with the development and delivery of health care apps is lacking. mHealth research should efficiently leverage the advantages of multidisciplinary research teams including software developers, designers, researchers, clinicians and marketing experts.

MBIs are highly heterogeneous in terms of intervention content and structure, practice hours, mode and frequency of delivery, expertise of the provider, etc. While there is growing evidence supporting the efficacy of MBIs to improve health outcomes in general, more research is needed to identify and analyse the moderating factors in these interventions. Results from that research would substantially aid the design of high quality mindfulness apps that have maximal effects.

9.5 CONCLUSION

This research program achieved its overall aim to evaluate the efficacy of a mindfulness-based mobile app. Smiling Mind app improved the wellbeing of the participants over the study period of the main randomised controlled trial, proving its efficacy. It is a challenge to choose a high quality mHealth app from the existing hundreds of apps. Study 1 was one of the first few studies to use a tool (the MARS) for evaluation of apps' subjective quality to inform better choice of apps for further efficacy studies. This methodology is a significant contribution to mHealth research. Studies 2 and 3 found that young people were able to adapt well to the novel method of delivering mindfulness training through apps. Further research is warranted to strengthen this claim and also to extend support to potential delivery of other interventions. The qualitative study identified the potential motivating factors for mindfulness practice and app usage which can inform future mindfulness app design and development. Overall the research program produced three scientific papers (one published and two submitted at the time of thesis submission) related to mindfulness mobile apps, which is a significant contribution to the small existing literature in this field of research.

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Appendices

Appendix A: Participant consent form and survey questionnaires

Consent

Efficacy of a mindfulness-based mobile app to improve wellbeing of Australian youth

QUT Ethics Approval Number 1400000827

RESEARCH TEAM

Principal Researcher	Associate Researchers
Madhavan Mani	Prof. David Kavanagh
PhD Candidate	A/Prof. Leanne Hides

School of Psychology and Counselling
Institute of Health and Biomedical Innovation
Queensland University of TechnologyFood

DESCRIPTION

Mindfulness is "the awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to things as they are." There is growing evidence that mindfulness can reduce stress and improve wellbeing. Mindfulness is a skill that can be developed by practice. There are many mindfulness-based mobile apps in the market. But the effectiveness of these apps is not established yet.

This project is being undertaken as part of PhD for Madhavan Mani. The aim of the research project is to evaluate the effectiveness of a mobile app to aid mindfulness and improve wellbeing of Australian youth aged 16-25 years.

Young people aged between 16-25 years with a smartphone (iPhone or Android phone), who are interested in learning how mindfulness skills can reduce their stress levels and improve their wellbeing are invited to participate.

This project is funded by the Young and Well Cooperative Research Centre (www.youngandwellcrc.org.au).

PARTICIPATION

Your participation will involve the following:

- Completing a brief (5 minute) online survey to assess your eligibility to participate
- Completing a 15 minute online survey assessing mindfulness skills and wellbeing at baseline (start of the study), 6, 12 and 18 weeks
- You will be allocated randomly to either immediate app-access group or delayed access in 6 weeks. You have an equal chance of being in either group
- Trial the mobile app for 12 weeks
- Some of you will be asked to participate in an audio recorded phone interview. This is optional. You will be asked to let us know what you thought about the mindfulness app

The time required for your participation depends on your app usage and how much you intend to practise mindfulness using the app. Your participation in this project is entirely voluntary. If you agree to participate you do not have to complete any question(s) you are uncomfortable answering.

Your decision to participate or not participate will in no way impact upon your current or future relationship with QUT. If you do agree to participate you can withdraw from the project at any time without comment or penalty. Any identifiable information already obtained from you will be destroyed at the end of the study.

EXPECTED BENEFITS

There is substantial evidence that mindfulness practice positively affects mental health. Hundreds of mindfulness-based mobile apps are available, but very few studies have examined their effectiveness. This research program will address this gap and determine the effectiveness of a popular mindfulness-based mobile app. It will also guide development of future mobile apps for mindfulness.
By taking part in this study, you will understand more about mindfulness and potentially benefit from the positive effects of mindfulness if the app is found to be effective. You will receive a gift of $80 ($20 for each completed survey), redeemable in iTunes or Google Play store.

RISKS

The selection procedure may draw attention to distress you experience. You will be provided with feedback on your current level of distress. The app used in the research is not intended to provide mental health treatment. You will be provided with the contact details of support services if needed. There is minimal risk that you may get distressed in using the apps that involves meditation practice and increasing self-awareness. You may find it discomforting to listen and follow the guided meditation tracks in the apps. There may be inconvenience caused due to giving up some time for the study. There is no other foreseeable harm or discomfort.
QUT provides limited free counselling for research participants of QUT projects who may experience discomfort or distress as a result of their participation in the research. Should you wish to access this service please contact the Clinic Receptionist of the QUT Psychology and Counselling Clinic on 07 3138 0999. Please indicate to the receptionist that you are a research participant.
Alternatively you can also contact:

- Kids Help Line 1800 55 1800 (24 hour) for telephone counselling and referrals
- Lifeline 13 11 14 (24-hour) for telephone counselling
- Headspace, the Australian Youth Mental Health Foundation
    - Provides information and counseling to young people aged 12 to 25 years on mental health issues; find your local headspace service at www.headspace.org.au
    - eHeadspace, www.eheadspace.org.au or 1800 650 890; offers online chat and telephone support

PRIVACY AND CONFIDENTIALITY

All comments and responses will be treated confidentially unless required by law. Any data collected as part of this project will be stored securely as per QUT's Management of research data policy.

QUESTIONS / FURTHER INFORMATION ABOUT THE PROJECT

If have any questions or require further information please contact the research team:

CONCERNS / COMPLAINTS REGARDING THE CONDUCT OF THE PROJECT

QUT is committed to research integrity and the ethical conduct of research projects. However, if you do have any concerns or complaints about the ethical conduct of the project you may contact

the QUT Research Ethics Unit on 07 3138 5123 or email ethicscontact@qut.edu.au. The QUT Research Ethics Unit is not connected with the research project and can facilitate a resolution to your concern in an impartial manner.

CONSENT TO PARTICIPATE

You have to provide your consent through an online form provided at the beginning of the screening and baseline survey, indicating that you:

- Have read and understood the information regarding this project
- Have had any questions answered to your satisfaction
- Understand that if you have any additional questions you can contact the research team.
- Understand that you can contact the QUT Research Ethics Unit on 07 3138 5123 or email ethicscontact@qut.edu.au. The QUT Research Ethics Unit is not connected with the research project and can facilitate a resolution to your concern in an impartial manner
- Agree to complete assessment surveys at baseline (start of the study), 6, 12 and 18 weeks
- May or may not agree to participate in audio recorded phone interview
- Give permission to collect your app usage data from the app provider
- Give permission for de-identified information collected in the research to be used for future studies
- Understand that you are free to withdraw at any time, without comment or penalty

Submitting the completed survey is a further indication of your consent to participate in this project.

Thank you for helping with this research project. Please keep this sheet for your information.

CONSENT TO PARTICIPATE

☐ I agree to participate in this research

☐ I am willing to participate in phone interview

Eligibility

How old are you?

Age (in years): _____

Do you have access to an iPhone (iOS 5 or above) or an Android phone (Android 2.3.3 or above)?

O No O iPhone O Android phone

K10

Please tick the answer that is correct for you.

In the past 4 weeks, about how often did you feel...

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
Tired out for no good reason?	O	O	O	O	O
Nervous?	O	O	O	O	O
So nervous that nothing could calm you down?	O	O	O	O	O
Hopeless?	O	O	O	O	O
Restless or fidgety?	O	O	O	O	O
So restless that you could not sit still?	O	O	O	O	O
Depressed?	O	O	O	O	O
That everything was an effort?	O	O	O	O	O
So sad that nothing could cheer you up?	O	O	O	O	O
Worthless?	O	O	O	O	O

Mindfulness Screen

Mindfulness is the self regulation of attention with an attitude of curiosity, openness and acceptance. Training in mindfulness is usually delivered through a range of meditation practices where you are taught how to pay attention to body sensations (e.g., your breath), emotions and thoughts in an accepting way.

Mindfulness meditation training and practice can take place in classrooms, via

websites and apps or through pre-recorded audio exercises. Mindfulness meditation is also commonly included in yoga and tai-chi classes.

Have you ever done any mindfulness training?

- ○ Yes
- ○ No

How did you do the mindfulness training? (please tick all that apply)

- ☐ Guided group mindfulness meditation training
- ☐ Individual guided mindfulness meditation training
- ☐ Tai chi
- ☐ Yoga with mindfulness training
- ☐ Websites providing guided mindfulness meditation training
- ☐ Audio recordings of mindfulness meditation training or practice
- ☐ Mindfulness meditation training or practice smartphone apps
- ☐ Mindfulness meditation training as part of psychological treatment
- ☐ Other (please specify) _____

What type of mindfulness training have you done? (please tick all that apply)

- ☐ Mindfulness Based Stress Reduction (MBSR)
- ☐ Mindfulness Based Cognitive Therapy (MBCT)
- ☐ Vipassana
- ☐ Zen
- ☐ Mantra-based (eg. transcendental meditation)
- ☐ Other _____
- ☐ Not sure

On average, how often have you engaged in formal mindfulness training or

practice **in the last month**?

- ○ More than once a day
- ○ Daily
- ○ 2-3 times a week
- ○ Weekly
- ○ Fortnightly
- ○ Once
- ○ None

Contact Details

Please confirm your primary email id and mobile number

Email	
Mobile number	

Please provide secondary contact details (as many as possible)

Email	
Mobile/Home phone	
Skype / Facetime id	

Demographics

What is the highest level of education you have completed?

- ○ No formal education
- ○ Completed or partially completed primary school
- ○ Completed or partially completed junior high school
- ○ Completed or partially completed senior high school
- ○ Certificate III / IV

- ○ Diploma or Advanced Diploma
- ○ Bachelor Degree
- ○ Postgraduate / PhD

What categories of app do you use mostly?

- ☐ Entertainment
- ☐ Games
- ☐ Social Networking
- ☐ Music
- ☐ Physical Health
- ☐ Mental Health
- ☐ Others

How Often do you use a mental health app? (e.g. Weekly [3 times], Daily [once])

- ○ Never
- ○ Daily
- ○ Weekly
- ○ Monthly

Name the app that you used for the longest period. How long did you use it and what made you use it for long?

Which feature in an app is most important for you?

- ☐ Engagement (fun, interesting, interactive)

☐ Functionality (app function, flow logic, navigation)

☐ Aesthetics (visual appeal, graphic design, colour scheme)

☐ Information (text content, references)

☐ Others

Have you ever been diagnosed with any of the following psychotic disorders?

- Brief Psychotic Disorder
- Delusional Disorder
- Schizophrenia
- Schizophreniform Disorder
- Schizoaffective Disorder
- Shared Psychotic Disorder
- Psychotic Disorder due to a general medical condition
- Substance-Induced Psychotic Disorder
- Psychotic Disorder Not Otherwise Specified

○ Yes ○ No

MHC-SF

Please tick the answer that is correct for you.

During the past month, how often did you feel...

	Never	Once or twice	Once a week	2 or 3 times a week	Almost every day	Everyday
1. happy	○	○	○	○	○	○

2. interested in life	O	O	O	O	O	O
3. satisfied with life	O	O	O	O	O	O
4. that you had something important to contribute to society	O	O	O	O	O	O
5. that you belonged to a community (like a social group, your school, or your neighbourhood	O	O	O	O	O	O
6. that our society is a good place, or is becoming a better place, for all people	O	O	O	O	O	O
7. that people are basically good	O	O	O	O	O	O
8. that the way our society works made sense to you	O	O	O	O	O	O
9. that you liked most parts of your personality	O	O	O	O	O	O
10. good at managing the responsibilities of your daily life	O	O	O	O	O	O
11. that you had warm and trusting relationships with others	O	O	O	O	O	O
12. that you had experiences that challenged you to grow and become a better person	O	O	O	O	O	O
13. confident to think or express your own ideas and opinions	O	O	O	O	O	O
14. that your life has a sense of direction or meaning to it	O	O	O	O	O	O

CAMS-R

People have a variety of ways of relating to their thoughts and feelings. For each of the items below, rate how much each of these ways applies to you.

	Rarely / Not at all	Sometimes	Often	Almost always
It is easy for me to concentrate on what I am doing.	O	O	O	O
I am preoccupied by the future.	O	O	O	O
I can tolerate emotional pain.	O	O	O	O
I can accept things I cannot change.	O	O	O	O

I can usually describe how I feel at the moment in considerable detail.	O	O	O	O
I am easily distracted.	O	O	O	O
I am preoccupied by the past.	O	O	O	O
It's easy for me to keep track of my thoughts and feelings.	O	O	O	O
I try to notice my thoughts without judging them.	O	O	O	O
I am able to accept the thoughts and feelings I have.	O	O	O	O
I am able to focus on the present moment.	O	O	O	O
I am able to pay close attention to one thing for a long period of time.	O	O	O	O

OHQ

Below are a number of statements about happiness. Please indicate how much you agree or disagree with each.

	Strongly disagree	Moderately disagree	Slightly disagree	Slightly agree	Moderately agree
I feel fully mentally alert	O	O	O	O	O
I don't feel particularly pleased with the way I am.	O	O	O	O	O
I feel that life is very rewarding.	O	O	O	O	O
I am well satisfied about everything in my life.	O	O	O	O	O
I can fit in everything I want to	O	O	O	O	O
I don't think I look attractive	O	O	O	O	O
I find beauty in some things	O	O	O	O	O
I do not have particularly happy memories of the past	O	O	O	O	O

Powered by Qualtrics

Appendix B: Mobile App Rating Scale (MARS)

Mobile Application Rating Scale (MARS)

App Classification

The Classification section is used to collect descriptive and technical information about the app. Please review the app description in iTunes / Google Play to access this information.

App Name: _____

Rating this version: _____ **Rating all versions:** _____

Developer: _____

N ratings this version: _____ **N ratings all versions:** _____

Version: _____ **Last update:** _____

Cost - basic version: _____ **Cost - upgrade version:** _____

Platform: ☐ iPhone ☐ iPad ☐ Android ☐ Other _____

Brief description: _____

_____

Focus: what the app targets (select all that apply)

- ☐ Increase Happiness/Well-being
- ☐ Mindfulness/Meditation/Relaxation
- ☐ Reduce negative emotions
- ☐ Depression
- ☐ Anxiety/Stress
- ☐ Anger
- ☐ Behaviour change
- ☐ Alcohol /Substance Use
- ☐ Goal Setting
- ☐ Entertainment
- ☐ Relationships
- ☐ Physical health
- ☐ Other _____

Theoretical background/Strategies (all that apply)

- ☐ Assessment
- ☐ Feedback
- ☐ Information/Education
- ☐ Monitoring/Tracking
- ☐ Goal setting
- ☐ Advice /Tips /Strategies /Skills training
- ☐ CBT - Behavioural (positive events)
- ☐ CBT – Cognitive (thought challenging)
- ☐ ACT - Acceptance commitment therapy
- ☐ Mindfulness/Meditation
- ☐ Relaxation
- ☐ Gratitude
- ☐ Strengths based
- ☐ Other _____

Affiliations:

☐ Unknown ☐ Commercial ☐ Government ☐ NGO ☐ University

Age group (all that apply)

- ☐ Children (under 12)
- ☐ Adolescents (13-17)
- ☐ Young Adults (18-25)
- ☐ Adults
- ☐ General

Technical aspects of app (all that apply)

- ☐ Allows sharing (Facebook, Twitter, etc.)
- ☐ Has an app community
- ☐ Allows password-protection
- ☐ Requires login
- ☐ Sends reminders
- ☐ Needs web access to function

QUT Queensland University of Technology

YOUNGANDWELL Cooperative Research Centre

App Quality Ratings

The Rating scale assesses app quality on four dimensions. All items are rated on a 5-point scale from "1.Inadequate" to "5.Excellent". Circle the number that most accurately represents the quality of the app component you are rating. Please use the descriptors provided for each response category.

SECTION A

Engagement – fun, interesting, customisable, interactive (e.g. sends alerts, messages, reminders, feedback, enables sharing), well-targeted to audience

1. **Entertainment: Is the app fun/entertaining to use? Does it use any strategies to increase engagement through entertainment (e.g. through gamification)?**

    1 Dull, not fun or entertaining at all
    2 Mostly boring
    3 OK, fun enough to entertain user for a brief time (< 5 minutes)
    4 Moderately fun and entertaining, would entertain user for some time (5-10 minutes total)
    5 Highly entertaining and fun, would stimulate repeat use

2. **Interest: Is the app interesting to use? Does it use any strategies to increase engagement by presenting its content in an interesting way?**

    1 Not interesting at all
    2 Mostly uninteresting
    3 OK, neither interesting nor uninteresting; would engage user for a brief time (< 5 minutes)
    4 Moderately interesting; would engage user for some time (5-10 minutes total)
    5 Very interesting, would engage user in repeat use

3. **Customisation: Does it provide/retain all necessary settings/preferences for apps features (e.g. sound, content, notifications, etc.)?**

    1 Does not allow any customisation or requires setting to be input every time
    2 Allows insufficient customisation limiting functions
    3 Allows basic customisation to function adequately
    4 Allows numerous options for customisation
    5 Allows complete tailoring to the individual's characteristics/preferences, retains all settings

4. **Interactivity: Does it allow user input, provide feedback, contain prompts (reminders, sharing options, notifications, etc.)? Note: these functions need to be customisable and not overwhelming in order to be excellent.**

    1 No interactive features and/or no response to user interaction
    2 Insufficient interactivity, or feedback, or user input options, limiting functions
    3 Basic interactive features to function adequately
    4 Offers a variety of interactive features/feedback/user input options
    5 Very high level of responsiveness through interactive features/feedback/user input options

5. **Target group: Is the app content (visual information, language, design) appropriate for your target audience?**

    1 Completely inappropriate/unclear/confusing
    2 Mostly inappropriate/unclear/confusing
    3 Acceptable but not targeted. May be inappropriate/unclear/confusing
    4 Well-targeted, with negligible issues
    5 Perfectly targeted, no issues found

A. Engagement mean score = _____

SECTION B

Functionality – app functioning, easy to learn, navigation, flow logic, and gestural design of app

6. **Performance: How accurately/fast do the app features (functions) and components (buttons/menus) work?**

    1 App is broken; no/insufficient/inaccurate response (e.g. crashes/bugs/broken features, etc.)
    2 Some functions work, but lagging or contains major technical problems
    3 App works overall. Some technical problems need fixing/Slow at times
    4 Mostly functional with minor/negligible problems
    5 Perfect/timely response; no technical bugs found/contains a 'loading time left' indicator

7. **Ease of use: How easy is it to learn how to use the app; how clear are the menu labels/icons and instructions?**

    1 No/limited instructions; menu labels/icons are confusing; complicated
    2 Useable after a lot of time/effort
    3 Useable after some time/effort
    4 Easy to learn how to use the app (or has clear instructions)
    5 Able to use app immediately; intuitive; simple

8. **Navigation: Is moving between screens logical/accurate/appropriate/ uninterrupted; are all necessary screen links present?**

    1 Different sections within the app seem logically disconnected and random/confusing/navigation is difficult
    2 Usable after a lot of time/effort
    3 Usable after some time/effort
    4 Easy to use or missing a negligible link
    5 Perfectly logical, easy, clear and intuitive screen flow throughout, or offers shortcuts

9. **Gestural design: Are interactions (taps/swipes/pinches/scrolls) consistent and intuitive across all components/screens?**

    1 Completely inconsistent/confusing
    2 Often inconsistent/confusing
    3 OK with some inconsistencies/confusing elements
    4 Mostly consistent/intuitive with negligible problems
    5 Perfectly consistent and intuitive

B. Functionality mean score = _____

SECTION C

Aesthetics – graphic design, overall visual appeal, colour scheme, and stylistic consistency

10. **Layout: Is arrangement and size of buttons/icons/menus/content on the screen appropriate or zoomable if needed?**

    1 Very poor design, cluttered, some options impossible to select/locate/see/read. Device display not optimised
    2 Poor design, random, unclear, some options difficult to select/locate/see/read
    3 Satisfactory, few problems with selecting/locating/seeing/reading items or with minor screen-size problems
    4 Mostly clear, able to select/locate/see/read items
    5 Professional, simple, clear, orderly, logically organised, device display optimised. Every design component has a purpose

11. Graphics: How high is the quality/resolution of graphics used for buttons/icons/menus/content?

1 Graphics appear amateur, very poor visual design - disproportionate, completely stylistically inconsistent
2 Low quality/low resolution graphics; low quality visual design – disproportionate, stylistically inconsistent
3 Moderate quality graphics and visual design (generally consistent in style)
4 High quality/resolution graphics and visual design – mostly proportionate, stylistically consistent
5 Very high quality/resolution graphics and visual design - proportionate, stylistically consistent throughout

12. Visual appeal: How good does the app look?

1 No visual appeal, unpleasant to look at, poorly designed, clashing/mismatched colours
2 Little visual appeal – poorly designed, bad use of colour, visually boring
3 Some visual appeal – average, neither pleasant, nor unpleasant
4 High level of visual appeal – seamless graphics – consistent and professionally designed
5 As above + very attractive, memorable, stands out; use of colour enhances app features/menus

C. Aesthetics mean score = _____

SECTION D

Information – Contains high quality information (e.g. text, feedback, measures, references) from a credible source. Select N/A if the app component is irrelevant.

13. Accuracy of app description (in app store): Does app contain what is described?

1 Misleading. App does not contain the described components/functions. Or has no description
2 Inaccurate. App contains very few of the described components/functions
3 OK. App contains some of the described components/functions
4 Accurate. App contains most of the described components/functions
5 Highly accurate description of the app components/functions

14. Goals: Does app have specific, measurable and achievable goals (specified in app store description or within the app itself)?

N/A Description does not list goals, or app goals are irrelevant to research goal (e.g. using a game for educational purposes)
1 App has no chance of achieving its stated goals
2 Description lists some goals, but app has very little chance of achieving them
3 OK. App has clear goals, which may be achievable.
4 App has clearly specified goals, which are measurable and achievable
5 App has specific and measurable goals, which are highly likely to be achieved

15. Quality of information: Is app content correct, well written, and relevant to the goal/topic of the app?

N/A There is no information within the app
1 Irrelevant/inappropriate/incoherent/incorrect
2 Poor. Barely relevant/appropriate/coherent/may be incorrect
3 Moderately relevant/appropriate/coherent/and appears correct
4 Relevant/appropriate/coherent/correct
5 Highly relevant, appropriate, coherent, and correct

16. **Quantity of information: Is the extent coverage within the scope of the app; and comprehensive but concise?**

N/A There is no information within the app
1 Minimal or overwhelming
2 Insufficient or possibly overwhelming
3 OK but not comprehensive or concise
4 Offers a broad range of information, has some gaps or unnecessary detail; or has no links to more information and resources
5 Comprehensive and concise; contains links to more information and resources

17. **Visual information: Is visual explanation of concepts – through charts/graphs/images/videos, etc. – clear, logical, correct?**

N/A There is no visual information within the app (e.g. it only contains audio, or text)
1 Completely unclear/confusing/wrong or necessary but missing
2 Mostly unclear/confusing/wrong
3 OK but often unclear/confusing/wrong
4 Mostly clear/logical/correct with negligible issues
5 Perfectly clear/logical/correct

18. **Credibility: Does the app come from a legitimate source (specified in app store description or within the app itself)?**

1 Source identified but legitimacy/trustworthiness of source is questionable (e.g. commercial business with vested interest)
2 Appears to come from a legitimate source, but it cannot be verified (e.g. has no webpage)
3 Developed by small NGO/institution (hospital/centre, etc.) /specialised commercial business, funding body
4 Developed by government, university or as above but larger in scale
5 Developed using nationally competitive government or research funding (e.g. Australian Research Council, NHMRC)

19. **Evidence base: Has the app been trialled/tested; must be verified by evidence (in published scientific literature)?**

N/A The app has not been trialled/tested
1 The evidence suggests the app does not work
2 App has been trialled (e.g., acceptability, usability, satisfaction ratings) and has partially positive outcomes in studies that are not randomised controlled trials (RCTs), or there is little or no contradictory evidence.
3 App has been trialled (e.g., acceptability, usability, satisfaction ratings) and has positive outcomes in studies that are not RCTs, and there is no contradictory evidence.
4 App has been trialled and outcome tested in 1-2 RCTs indicating positive results
5 App has been trialled and outcome tested in $\geq$ 3 high quality RCTs indicating positive results

D. Information mean score = _____ *

* Exclude questions rated as "N/A" from the mean score calculation.

App subjective quality

SECTION E

20. Would you recommend this app to people who might benefit from it?

1	**Not at all**	I would not recommend this app to anyone
2		There are very few people I would recommend this app to
3	**Maybe**	There are several people whom I would recommend it to
4		There are many people I would recommend this app to
5	**Definitely**	I would recommend this app to everyone

21. How many times do you think you would use this app in the next 12 months if it was relevant to you?

1 **None**
2 1-2
3 3-10
4 10-50
5 >50

22. Would you pay for this app?

1 No
3 Maybe
5 Yes

23. What is your overall star rating of the app?

1	★	One of the worst apps I've used
2	★★	
3	★★★	Average
4	★★★★	
5	★★★★★	One of the best apps I've used

Scoring

App quality scores for

SECTION

A: Engagement Mean Score = _____

B: Functionality Mean Score = _____

C: Aesthetics Mean Score = _____

D: Information Mean Score = _____

App quality mean Score = _____

App subjective quality Score = _____

App-specific

These added items can be adjusted and used to assess the perceived impact of the app on the user's knowledge, attitudes, intentions to change as well as the likelihood of actual change in the target health behaviour.

SECTION F

1. **Awareness: This app is likely to increase awareness of the importance of addressing [insert target health behaviour]**

Strongly disagree				Strongly Agree
1	2	3	4	5

2. **Knowledge: This app is likely to increase knowledge/understanding of [insert target health behaviour]**

Strongly disagree				Strongly Agree
1	2	3	4	5

3. **Attitudes: This app is likely to change attitudes toward improving [insert target health behaviour]**

Strongly disagree				Strongly Agree
1	2	3	4	5

4. **Intention to change: This app is likely to increase intentions/motivation to address [insert target health behaviour]**

Strongly disagree				Strongly Agree
1	2	3	4	5

5. **Help seeking: Use of this app is likely to encourage further help seeking for [insert target health behaviour] (if it's required)**

Strongly disagree				Strongly Agree
1	2	3	4	5

6. **Behaviour change: Use of this app is likely increase/decrease [insert target health behaviour]**

Strongly disagree				Strongly Agree
1	2	3	4	5

Appendix C: Ethics Approval

From: QUT Research Ethics Unit
To: David Kavanagh; Leanne Hides; Madhavan Mani; Madhavan Mani
Cc: Janette Lamb
Subject: Ethics application - approved - 1400000827
Date: Friday, 13 February 2015 11:47:55 AM
Attachments: UHRECSTANDARDCONDITIONSOFAPPROVAL-HUMANRESEARCH.DOC

Dear Prof David Kavanagh and Mr Madhavan Mani

Project Title: A randomised controlled trial of a mindfulness-based mobile app to improve wellbeing of Australian youth

Ethics Category: Human - Committee
Approval Number: 1400000827
Approved Until: 13/02/2017
(subject to receipt of satisfactory progress reports)

We are pleased to advise that your application has been reviewed by the University Human Research Ethics Committee (UHREC) and confirmed as meeting the requirements of the National Statement on Ethical Conduct in Human Research.

I can therefore confirm that your application is APPROVED.
If you require a formal approval certificate, please advise via reply email.

CONDITIONS OF APPROVAL
Please ensure you and other team members read through and understand all UHREC conditions of approval prior to commencing any data collection:
- Standard: Please see attached or http://www.orei.qut.edu.au/human/stdconditions.jsp
- Specific: None apply

Whilst the data collection of your project has received QUT ethical clearance, the decision to commence and authority to commence may be dependent on factors beyond the remit of the QUT ethics review process. For example, your research may need ethics clearance from other organisations or permissions from other organisations to access staff. Therefore the proposed data collection should not commence until you have satisfied these requirements.

Please don't hesitate to contact us if you have any queries.

We wish you all the best with your research.

Kind regards

Janette Lamb on behalf of Chair UHREC
Office of Research Ethics & Integrity
Level 4 | 88 Musk Avenue | Kelvin Grove
p: +61 7 3138 5123
e: ethicscontact@qut.edu.au
w: http://www.orei.qut.edu.au

Queensland University of Technology
Brisbane Australia

PARTICIPATE IN RESEARCH

Information for Prospective Participants

The following research activity has been reviewed via QUT arrangements for the conduct of research involving human participation.
If you choose to participate, you will be provided with more detailed participant information, including who you can contact if you have any concerns.

A RCT of a mindfulness-based mobile app to improve wellbeing of Australian youth

Research team contacts

Principal Researcher:	Madhavan Mani	07 3138 6398	m.mani@qut.edu.au
Principal Supervisor:	Prof David Kavanagh	07 3138 6143	david.kavanagh@qut.edu.au
Associate Supervisor:	A/Prof Leanne Hides	07 3138 6144	leanne.hides@qut.edu.au

What is the purpose of the research?

Mindfulness is "the awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to things as they are." There is growing evidence that mindfulness can reduce stress and improve wellbeing. Mindfulness is a skill that can be developed by practice. There are many mindfulness-based mobile apps in the market. But the effectiveness of these apps is not established yet.

The aim of the research project is to evaluate the effectiveness of a mobile app to aid mindfulness and improve wellbeing of Australian youth aged 16-25 years.

Are you looking for people like me?

The research team is looking for young people (males and females) aged between 16 to 25 year who have access to a smartphone (iPhone or Android phone) and are comfortable to use apps.

What will you ask me to do?

Your participation will involve the following:

- Completing a brief (5 minute) online survey to assess your eligibility to participate.
- Completing a 15 minute online survey assessing mindfulness skills and wellbeing at baseline (start of the study), 6, 12 and 18 weeks.
- You will be allocated randomly to either immediate app-access group or delayed access in 3 months' time. You have an equal chance of being in either group.
- Trial the mobile app for 12 weeks.
- Some of you will be asked to participate in an audio recorded phone interview. This is optional. You will be asked to let us know what you thought about the mindfulness app.

Are there any risks for me in taking part?

The selection procedure may draw attention to distress you experience. You will be provided with feedback on how your current level of distress compares to other young people and will be provided with the contact details of support services if needed. The research team does not believe there are any risks beyond normal day-to-day living associated with your participation in this research. It should be noted that if you do agree to participate, you can withdraw from participation at any time without comment or penalty.

Are there any benefits for me in taking part?

There is substantial evidence that mindfulness practice positively affects mental health. By taking part in this study, you will understand more about mindfulness and potentially benefit from the positive effects of mindfulness if the app is found to be effective.

Will I be compensated for my time?

You will receive a gift of $60($15, $20 and $25 respectively for each completed follow-up surveys at 6, 12 and 18 weeks), redeemable in iTunes or Google Play store.

Who is funding this research?

This project is funded by the Young and Well Cooperative Research Centre (www.youngandwellcrc.org.au).

I am interested – what should I do next?

If you would like to participate in this study, please contact Madhavan Mani at **m.mani@qut.edu.au**.

You will be provided with further information to ensure that your decision and consent to participate is fully informed.

Thank You!

QUT Ethics Approval Number: 1400000827

Appendix D: Participant Information Sheet